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The New Hamburg-American Oil Engine Ship "Christian X"

No greater sensation has occurred in British marine-engineering circles in many years than happened on Feb. 27 last, when the "Selandia," the first large ocean steamer to be equipped with Diesel oil engines, and built in Copenhagen, Denmark, arrived in an English port. It was one thing for British shipbuilders and marine engineers to read of the rapid progress of the Diesel engine applied to the ships being built in Russia, Germany, Austria, and other continental nations, and another to see a full-sized ocean vessel, ranking with the largest class of ocean freight carriers, being propelled wholly by internal combustion engines.

Of course, shipping and shipbuilding is a small industry in the United States compared with what it is in England; but it created a somewhat similar sensation in American marine-engineering circles when a sister ship of the "Selandia," the "Christian X," owned by the Hamburg-American Line, entered New York Harbor on Wednesday, Sept. 18. On the afternoon of the following day, by the courtesy of the Hamburg-American Line, a reception was held on board the new vessel and a large number of engineers from New York and vicinity took advantage of the opportunity to visit and inspect this fine example of a new era in shipping.

The accompanying photograph gives a good idea of the general appearance of the vessel which, it will be seen, resembles in size and build a regular transatlantic liner rather than an ordinary freight steamer. And, in fact, the "Christian X" is no ordinary vessel.

Her hull is 320 ft. in length, with 53-ft. beam, and 30 ft. molded depth. She has a displacement of about 9800 tons and her registered tonnage is 4900 gross and 3200 net.

As stated above, the "Christian X" is a sister ship of the "Selandia" and was constructed at the yards of the same shipbuilding firm, Burmeister & Wain, of Copenhagen, Denmark. We do not at all exaggerate in saying that the vessel is one which any shipbuilding firm in the world might be proud to have produced. Especially noteworthy are the luxurious accommodations for passengers, in great contrast to those provided on the ordinary vessel designed primarily for carrying freight. We know of no vessel leaving the port of New York, short of the latest built transatlantic greyhounds, which can boast any such handsome and luxurious quarters for passengers as are provided on the "Christian X."

There may well be sound business judgment behind this provision of seemingly extravagant passenger accommodations. A very large proportion of those who travel by sea for pleasure far prefer to travel by slow vessels and even by those of moderate size rather than by the latest products of marine architecture in which the length of a trans-oceanic journey is reduced to a small part of a week and in which the enormous size of a ship's company forbids the development of general acquaintance and goodfellowship which was so attractive a part of an ocean voyage a few years ago. There

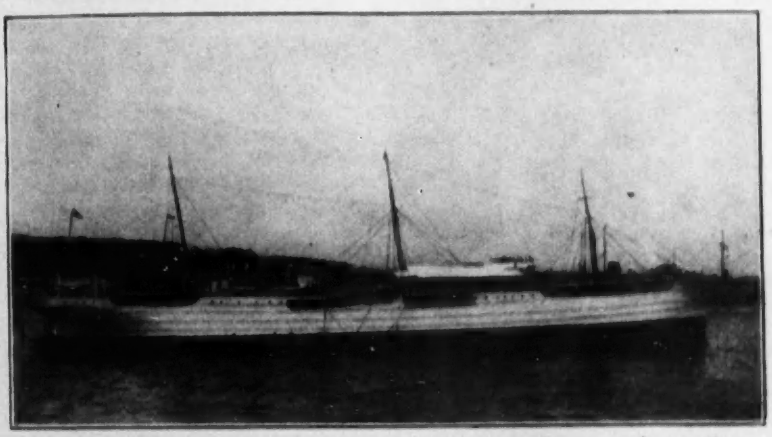

FIG. 1. THE OIL ENGINE SHIP "CHRISTIAN X," HAMBURG AMERICAN LINE. BURMEISTER & WAIN, COPENHAGEN, DENMARK, BUILDERS
(370 ft. long, 53-ft. beam, 9800 tons displacement. 1700 hp.—12 knots speed).

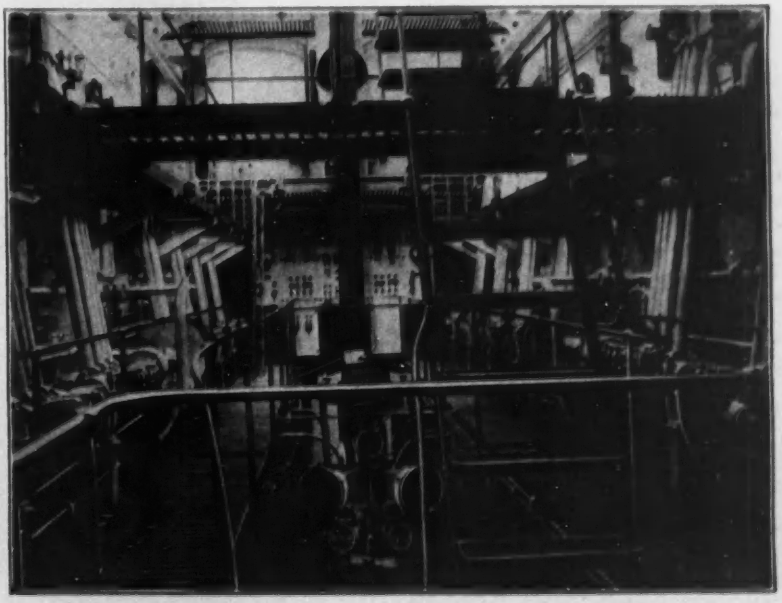

FIG. 2. A VIEW IN THE ENGINE ROOM OF THE "CHRISTIAN X"
(Two Diesel four-stroke cycle oil engines, eight cylinders each).

is the additional fact to be noted that passengers traveling on this new vessel will have none of the troubles from smoke, heat and gas from the engines which often are a disagreeable feature in steamship travel, especially in case of a following wind.

The recent log of the "Christian X" shows that she left the River Elbe on July 23, bound for Havana. After the ship had left the English Channel and was well out on the open Atlantic, free from any currents and under fine weather conditions, a trial run of 24 hours was made, in which the average speed was 11½ miles per hour. Rough weather was encountered later in the voyage, but we are informed that the engines worked smoothly without interruption all the time. The ship arrived at Havana on Aug. 9, having covered 4627 miles in 17 days at an average speed of 11.01 miles per hour. From Havana the vessel went to New Orleans, where she loaded with cargo for Europe. She sailed from New Orleans Sept. 13 and reached New York Sept. 19. Here her fuel tanks were filled with oil previous to starting on her voyage across the Atlantic. The owners inform us that her average fuel consumption is about 10 tons of oil per day, and as the fuel-oil tanks have a capacity of about 1000 tons, the ship can carry fuel enough at one time to enable her to sail entirely around the world. Thus, according to the market conditions of oil and freights, the fuel tanks of the vessel can be replenished when and where it can be done most economically.

Chief interest, of course, centers around the engines by which the "Christian X" is propelled. These are two eight-cylinder Diesel engines working on the four-stroke-cycle system. On the head of each cylinder are two exhaust valves, an air-inlet valve, the fuel-inlet valve, a release valve for excessive pressure and an air starting valve. The long inclined rods by which the valves on the exhaust and inlet ports and the fuel inlets are operated form a noticeable feature in the view of the engine room. The engines have crossheads and slides, but are entirely inclosed. Salt water for cooling is circulated through the cylinder jackets. The crosshead guides are also water-cooled. The total indicated power of the two sets of engines is about 2500 hp. at 140 revolutions, or a little less than 200 hp. per cylinder.

As is practically the universal custom in Diesel engines of large size, the starting is done by compressed air, special air admission valves being fitted to each cylinder. The cam shaft operating the valves can be moved lengthwise in its bearings to bring either the set of cams for going ahead or for going backward into action. As soon as the engine is in motion, the injection of oil commences and the air starting valves are automatically closed. It is said that the engine can be reversed from full speed ahead to full speed astern in eight seconds.

In order to furnish the compressed air for starting and maneuvering, two auxiliary Diesel engines of 250 hp. each are installed, one on each side of the main engine room. Each of these drives both an electric generator and an air compressor and either or both of them are thus available for lighting the ship and for filling the compressed-air reservoirs from which the supply is drawn for starting and maneuvering the main engines. The exhaust from the main engines is taken into exhaust-pipe trunks which are water-jacketed, thence through a muffler and then up the hollow steel mizzen-mast.

When properly adjusted the combustion in the Diesel engine cylinders is so complete that practically no smoke escapes from the opening at the top of the mizzen-mast, and the issuing vapor of the exhaust is invisible.

Besides the air compressors driven by the auxiliary engines, each main engine drives an air compressor which takes in air from the starting reservoirs at a pressure of 300 lb. and raises it to 900 lb. pressure for injecting the oil into the cylinders. These high-pressure compressors are automatically adjustable for either half capacity or full capacity. When running at half capacity each supplies the proper amount of air to atomize the fuel for its own engine; but if either compressor is out of order, the other compressor can work at full capacity and furnish injection air to both the main engines. As a still further reliance, in case the low-pressure air compressors driven by the auxiliary engines should both be out of order, there is provision by which the exhaust valve on one of the main engine cylinders can be removed and replaced by a delivery valve so that one of the cylinders of the main engines will then act as an air compressor and furnish air to the starting reservoirs and to the high-pressure compressor. The electric generators driven by the auxiliary engines furnish current for running a considerable number of auxiliary motors, such as electric lubricating pumps, circulating pumps, sanitary pumps, a refrigerating machine, etc. A still further provision for emergency is furnished by an oil-fired donkey boiler. This ordinarily provides steam for heating the vessel, but can also work a steam-driven air compressor which can operate up to 900 lb. per sq.in., and thus can furnish high-pressure air for fuel atomizing entirely independent of all the other compressors above enumerated. The lubrication system is especially noteworthy, according to a description of the system given in a paper read before the Institution of Naval Architects on Mar. 28 last:

> The electrically driven lubricating pump pumps the oil each from its own tank, which is placed in the bottom of the ship, through the main bearings, from there through the crankshaft and connecting-rod brasses, thence through the hollow bored connecting rods to the crosshead brasses, from there through the piston rod to the top of the oil-cooled piston, then back through the piston rod and from there it is ejected over the guides.

The donkey boiler above mentioned is also available for steam jets for extinguishing fires, but compressed air is used for operating the siren, the supply being taken at a pressure of about 120 lb. from the intermediate stage of the three-phase compressor driven by the auxiliary engines.

While the main oil fuel supply is contained in the ship's double bottom, large vertical settling tanks are provided in the engine room from which the engines draw their supply when in operation. In these tanks any sediment and water in the oil is allowed to settle out.

It may be remarked that the present tendency in the construction of marine Diesel engines is toward the adoption of the two-stroke-cycle system, which gives a much lighter engine for the same power and twice the number of impulses upon the crankshaft with a given number of cylinders. Engines of the "Christian X," therefore, represent a heavier type of machine than is likely to become standard. They are, however, a remarkable example of substantial and intricate design and workmanship. We do not know of a single shipbuilding or engine-building concern in the United States today which is equipped with designing staff and machinery competent to produce a Diesel engine equal to those of the "Christian X."

Even in England, the great shipbuilding nation of the world, there are extremely few firms which are as yet competent to build Diesel engines. It is, therefore, something in which the Danish nation may well take peculiar pride that an enterprising firm in their capital city has accomplished a feat in ship and engine construction equal at least to anything which either the United States or England can today produce.

A New Type of Centrifugal Pump for low heads and high-speed drives was described in "Engineering News," June 6, 1912. The runner had helicoidal vanes, somewhat like the blades of a screw propeller, projecting radially from a double conical body which deflected the two entering streams of water from an axial direction. This was invented by C. V. Kerr, Chief Engineer of McEwen Bros., Wellsville, N. Y. The design has now been adapted to blowers; double helical runners are used in the small sizes and, in the larger units, increasing-pitch propellers. Tests on a 16-in. blower of the first type are claimed to show up to 55% efficiency with pressures of from 2 to 10 in. water-gage, deliveries up to 6000 cu.ft. per min., and required horsepowers from 3 to 8.1. Maximum efficiency was observed at 10 in. pressure, 3700 cu.ft. delivery, 3800 r.p.m., and 7.7 hp.

The Austin Dam and Its Failure*

By T. Chalkley Hatton†

It seems to be appropriate to here present some features of the construction and subsequent failure of the Austin Dam as an argument in favor of Prof. McKibbin's proposition for state supervision of dams. [See following article. —Ed.]

This dam failed Jan. 23, 1910, and was demolished Sept. 30, 1911, over 18 months later.‡ After Jan. 23, 1910, the structure could not be termed a dam; it was a vertical wall broken in five or six distinct and separate sections. The same causes which effected the failure were only indirectly the cause of the demolition.

The Austin Dam failed at the intake, which was near the center of the spillway, by dropping down at the toe some 6 in. and sliding out at the spillway about 18 in. The concrete did not slide on its sandstone base, but one stratum of the underlying sandstone slid upon another after the intervening stratum of shale and gravel had been softened by the water seeping through this stratum.

This result was very apparent on the morning of Jan. 25, 1910, after the water was out. The intake walls, which were built against the upstream face of the dam, and at right angles thereto, were pulled apart near their center in an almost vertical separation 18 in. wide. The underlying rock strata upon which this wall was built had a vertical cleavage parallel with the face of the dam, about 12 ft. upstream from it, immediately under the vertical separation of the intake walls, and of the same width. No better evidence could be obtained as to what happened when this dam failed.

The center of the dam bowed down stream about 31 in. at the top, the bow running to zero about 110 or 115 ft. either way. There were four or five vertical cracks entirely through the dam in this 220 or 230 ft., and one vertical crack nearer the west end which did not extend the full depth of the wall. These cracks divided the dam into five or six distinct and separate sections.

As the dam slid down in the center the earth immediately below and adjacent to it was pushed up quite perceptibly. This earth and the underlying sandstone stratum, against which the downstream face of the dam was built, was the only thing which saved the dam from total demolition in 1910.

Since Jan. 25, 1910, water had been constantly impounded by this broken concrete wall. The depth of this water had varied from 25 to 52 ft. During this period water had continued to leak through the underlying stratum. This leakage going on at great pressure, must certainly have washed much of this shale and gravel away, leaving the heavy concrete walls with less and less foundation daily until the final collapse came on Sept. 30, 1911.

The conditions governing the design of the dam were not unusual. I had a client who placed upon me two limitations, minimum cost and maximum height. The first was $25,000 and the latter was determined by securing an impounding area for 200,000,000 gal. of water.

In order to fulfill these two conditions I made three separate designs, reducing each cross-section a little until I got the least which I believed to be safe. This section did not provide for any leakage under the dam, nor did I expect it. I knew the nature of the foundation, for I had sunk pits upon the site of the dam before designing it. I had also carefully examined the nature of the underlying rock, which could be clearly seen throughout the valley. I expected to prevent leakage under the dam by building a very stable upstream embankment against its face. By means of this embankment I also expected to reduce the hydrostatic pressure against the dam.

To increase the factor of safety against overturning I placed steel rods in the upstream portion of the wall. These rods were 1¼-in. steel, 25 ft. long, sunk 6 to 8 ft. in the underlying rock strata, and secured thereto by expansion bolts, the holes being filled with cement mortar.

To increase the factor of safety against sliding, a key or cut-off was built into the rock on the upstream face of the dam forming a vertical projection of the dam. This wall was 4 ft. wide and from 2 to 4 ft. deep.

The weak part of this dam was at the intake where there was no embankment against the upstream face, and where a hydrostatic pressure was exerted against the dam due to the full depth of water to its foundation, or approximately 53 ft. To overcome this extra pressure, I built a heavy concrete wall against the downstream face 10 ft. thick, 7 ft. deep and over the full length of the spillway. However, this is the point where the dam failed.

The great mistake I made in building this dam was trusting to the rock foundation as being impervious. I am just as fully alive to this mistake as are several of my critics, who seem to think a careful and experienced engineer could not have so erred in judgment; but I just want to tell these critics a few things which influenced my judgment.

About 860 ft. above the site of the new dam another dam had been built some 12 or 13 years before. This dam was 20 ft. high, and impounded about 26,000,000 gal. of water. It consisted of a rubble stone masonry core wall 12 in. thick on top, and stepped down to 4 ft. 6 in. on the bottom, which was built on the surface of the same sandstone stratum upon which the new dam was to be built. The dam had an embankment on the upstream face of 2 to 1. The embankment on the downstream face had been washed away, exposing about two-thirds of the core wall.

The only place where this dam leaked was through an old clean-out pipe which had been abandoned, and which the owners had unsuccessfully tried to stop up. There was no leakage apparent in the valley below.

When building the new dam I had the foundation rock drilled with 2-in. drills to a depth of from 10 to 15 ft., and from 15 to 20 ft. apart over the entire foundation. I did this for the purpose of testing the underlying strata. These holes were drilled under my personal supervision. These holes were free of water at all times, except such as was poured into them by the driller to prevent the heating of the tool. These holes were drilled through the same strata of rock upon which the water back of the old dam was lying and the bottom of the holes were 60 to 65 ft. below the surface elevation of the water. If these strata had not been water-tight my conclusion was that any leakage from the old dam would have shown in these holes.

This seemed a logical conclusion then, and, upon explaining the condition to many well informed engineers since, it has appeared to be logical to them.

The test holes sunk into the rock showed good solid strata of rock from 2 ft. to 4 ft., with intervening strata of gravel and shale. These strata were so compact that they were almost as hard to drill as the rock.

The concrete used in the heavier portion of the wall was what is known as "cyclopean." The large stones were embedded in various ways, some as headers and some as stretchers; some on their greatest beds, and some on edge. Every large stone was surrounded with from 4 in. to 12 in. of concrete, which was deposited very wet and well spaded in.

The concrete mass consisted of 1 volume of Pennsylvania portland cement, 3 parts of crushed sandstone dust and fine screenings and 6 parts of crushed sandstone, the run of the crusher up to 2½-in. stones. All the cement used was tested upon the work. A boiling, setting, and tensile test was made of every car load, and none was accepted which gave evidence of being unsound, of too rapid setting, or whose tensile strength was below 200 lb. for 24 hr., or 400 lb. for seven days, neat, or fell below 120 lb. after seven days old when mixed with three

*Condensed from a paper read at the Washington meeting of the New England Water Works Association, Sept. 18, 1912. The complete paper will be published in the "Journal" of the Association, probably accompanied by numerous illustrations.

†Wilmington, Del.

‡See Eng. News of Oct. 5, 1911, for description of failure and editorial discussion; also issues of Oct. 12, Oct. 19 and Oct. 26, for correspondence relating to the same.

parts of the crushed stone dust we were using in the work.

I have been building concrete for 25 years, under all kinds of conditions. I have tested it in a laboratory maintained under my direction for several years, and I believe I know what good concrete is when I see it laid, and I think I can truthfully declare here and now that I never had better concrete built for me than I had at the Austin Dam.

The failure of this dam was not the result of poor workmanship, but poor judgment upon my part in determining upon its foundation. I should have sought the advice of a man more skilled in determining foundations for dams than I was.

Had there been such a state officer it might have resulted in saving this dam and my reputation. I was also too much influenced in my judgment by the necessity for keeping the expenditure within certain limits. I have since felt a very grave responsibility for my failure to advise my client early in my engagement that no paring down of this work should be countenanced. Had I done so, either the dam would not have been built, or it would have been built in accordance with my first design.

The owner had no intention at any time of building a dam, the safety of which he doubted, and no blame can be attached to him for its failure on Jan. 23, 1910. He depended upon my judgment entirely, even though he may have tried to influence me to keep the expenditure down to the lowest possible limit.

To the young engineer who is called upon to design an important structure, the safety, or sufficiency of which, he is not entirely satisfied with, I would strongly urge the wisdom of calling to his help the advice of an older engineer especially skilled in the particular line involved. Never sacrifice safety for cost, no matter how urgent your client may become. He does not realize the danger and you should. If you cannot agree with him, resign your engagement, for sooner or later the reckoning will come.

Now just a word upon state supervision of dams. As previously stated in this paper, I think if a thoroughly competent state supervisor had been in office when this dam was designed it might never have failed; but how are you going to get such a supervisor?

Since the failure of this dam, and its subsequent demolition, I have read every criticism from engineers which has come to my notice. For the most part these criticisms have appeared in the several engineering journals and society reports. I have compiled a little book containing these clippings, as I have been most deeply interested in learning all I could about this matter; I have, perhaps, thus accumulated more evidence of the difference of opinion as to how to build a dam, as expressed by engineers in good standing, than others who have not had the same incentive. In view of this information I want to say it would take a pretty good examining board to pass upon the qualifications for a competent state dam supervisor.

In the discussion as to the proper method of reinforcing this dam after its failure in 1910, I have five different plans from as many engineers and each plan is based upon totally different principles.

To learn that the profession is not a unit upon just how to build a dam to make it safe, and still keep within the economic limits of cost, you need only refer to the numerous dam failures both in this and in foreign countries. Their number far surpasses the number of failures of any other class of engineering structures.

State Supervision of the Design, Construction and Operation of Dams and Reservoirs*

By Frank P. McKibben†

The failure of the dam at Austin, Penn., in September, 1911, has led engineers in that and several other states to voice a feeling for more careful supervision of such engineering construction as, if improperly carried out, may endanger life and property. To secure from the various legislatures the needed statutory powers to this end there is required united opinion and action on the part of the engineering societies in the several states, combined with agreement between the state societies and the American Society of Civil Engineers.

Already 27 states have laws intended to provide supervision of dams and reservoirs: Colorado, Connecticut, Florida, Georgia, Idaho, Indiana, Kansas, Maine, Massachusetts, Michigan, Montana, Nebraska, Nevada, New Jersey, New Mexico, New York, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Wyoming.

Fifteen states provide for state supervision, and 12 place local officials in control. In general, the laws of the Western states are more rigid and explicit than those of the Eastern states, and the laws of Oklahoma and Colorado are among the more stringent. The latter require the approval of plans for dams before construction, supervision during construction, and a certificate before use, all from the state engineer. In Colorado, county engineers must inspect the reservoirs within their counties annually.

Laws of the Eastern states are generally inadequate. In Pennsylvania the State Department of Health passes on plans for reservoirs for public water supplies and the State Water Supply Commission, under an act of 1907, has power to pass on dams built in streams which have been declared to be public highways by the legislature; but it has no jurisdiction over construction, nor over dams already built. The Austin dam did not come within the control of the State Water Supply Commission nor of any state authority. Since its failure the Commission, because of aroused public opinion, has made investigation of several dams suspected of being unsafe, and is also inspecting dams under construction. It is evident that Pennsylvania has not sufficient protection against unsafe dams, but when the next legislature meets there should be no difficulty in securing additional enactments. There are strong arguments in favor of combining several existing Pennsylvania commissions into a public-service commission or department of public works. The inadequacy of present laws for safeguarding against dam and reservoir failures is duplicated in lack of provision for oversight of bridges carrying railroad trains and street-railway cars.

State supervision of dams would need to be supplemented by federal control, in the case of interstate streams.

The following outline of a plan for state supervision of dams, embankments and reservoirs is suggested:

(1) Examination of plans and specifications by a properly organized state board whose approval is necessary before construction is begun. This approval should carry the proviso that a competent resident engineer be employed by the owner continuously at the dam under construction.

(2) Examination of the dam or embankment during construction by competent engineers in the employ of the board. Inasmuch as the majority of masonry dam failures have been caused by faulty foundations, it is quite evident that inspection of the foundation as well as the superstructure is necessary, and that the board acting through its chief engineer must have the authority to secure changes in plans and methods if geologic or other features of the site require such changes. To make state supervision complete and efficient, a capable state engineer must see the work at important stages. Changes in original plans and specifications should be permitted only when allowed in writing by the chief engineer, and after a dam is finished no alterations should be allowed except with the written consent of the board.

(3) Upon completion of the dam the state engineer should examine the structure and should require a report from the owner's engineer that the dam was built in accordance with approved plans and specifications and that the structure

*Abstract of a paper read before the New England Water Works Association at Washington, D. C., Sept. 18, 1912. The complete paper will appear in the "Journal" of the Association.

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is a safe structure for the purpose for which it is intended. If the structure and report be approved, the board should then issue a certificate of operation.

(4) Biennially after the dam is completed the owners should be required to have a competent engineer examine the dam and reservoir and to submit his report, together with any recommendation, to the board. It is the purpose of these biennial examinations to reveal any changes in and about the dam or reservoir which might endanger the safety of the structure.

(5) At intervals not greater than five years, and oftener, if necessary, the state engineer should examine each structure, and his reports should be published in the annual report of the board. In case any repairs are shown to be necessary, either by the owner's engineer or by the state engineer, the board should order the owner to make them or to lower the water, and if he refuses, the board should apply to the judge of the county court for enforcement. Furthermore, at any time upon petition of three or more residents or property owners who consider their lives or property in danger because of the presence of a suspected faulty dam, the state engineer should examine the structure, and if repairs are necessary the board should proceed as above. Nothing in the act should relieve the owner of his full responsibility for the safety of the structure.

Cost of Slides and Breaks in Culebra Cut, Panama Canal, in Cubic Yards of Excavation

Although engineers familiar with the physical conditions at the Culebra cut, Panama Canal, have put no faith in numerous newspaper reports greatly exaggerating the seriousness of the occasional slides and breaks, perhaps few have fully realized what large elements these slides have been in the work of excavation, and how enormously they have added to the original estimate of the cost of excavating the canal prism.

The total excavation, including what has already been done and that still required to complete the cut, was estimated, on July 1, 1912, to be 109,239,439 cu.yd., according to the *Canal Record* of Sept. 4. Of this immense total no less than 20,266,000 cu.yd., or 18½%, has been necessitated by slides or breaks in the sides of the cut. Both these totals will, of course, be increased by slides subsequent to June 30, 1912. Exclusive of the material carried into the cut by breaks and slides the amount of excavation would have amounted to 88,973,439 cu.yd., so that the slides have added 22.8% to the original estimate of material to be removed from the canal prism.

The amount of material required to be excavated as a result of slides has steadily increased from year to year as the cut became deeper. During the year which ended June 30, 1910, 14.83%, in 1911, 26.3%, and in 1912, 34.5% of the total amount excavated was the result of slides and breaks in the canal banks. For the year ending June 30, 1912, the total was 5,915,000 cu.yd., which is the greatest amount removed on this account in any one year since the beginning of operations.

The first large slide to occur in the banks of the canal in the Culebra cut section was that at Cucaracha, known as the Cucaracha slide, which developed in July, 1905, and from which nearly 3,000,000 cu.yd. of material have been excavated to date. During the twelve-month period ending June 30, 1912, only 170,000 cu.yd. of material were removed from this slide, which, at present, gives no evidence that there will be any considerable movement in the future. It covers an area of 47.1 acres.

The most extensive slide, or rather break, is that on the west bank of the canal at Culebra, which extends practically continuously from Sta. 1726 to Sta. 1804, covers an area of 63 acres, and has now broken back to a point where the site of the Culebra clubhouse is involved. From this area, a total of 6,765,500 cu.yd. of material had been removed up to June 30, 1912, and it is estimated that 1,300,000 cu.yd. remained to be excavated on that date. A total of 2,710,000 cu.yd. was taken out from the area involved in this slide during the twelve-month ending June 30, 1912. It first developed in January, 1907.

The slide next largest in extent is situated on the east bank of Culebra cut directly opposite the one on the west bank, is practically continuous from Sta. 1741 to Sta. 1796, and covers an area of 50.7 acres. A total of 4,290,000 cu.yd. of material had been removed from this slide up to June 30, 1912, and approximately 600,000 cu.yd. remained to be removed on that date. It first developed in January, 1907.

The three slides above described are the only ones which have so far developed in which the total amount of material involved exceeded 1,000,000 cu.yd. Altogether there have been 18 slides, varying in amounts from 18,000 cu.yd. to the great one already mentioned at Culebra, which involved over 8,000,000 cu.yd., not including a number of small ones which together amounted to about 900,000 cu.yd. The area included in all the slides amounted to 208 acres.

Since June 30, 1912, two or three other slides have developed, the most important being the break in the east bank of the cut about one-half mile north of Empire, which occurred on Aug. 20, and allowed the water in the Obispo diversion to flow into the cut, and another break in the west bank at Culebra.

The work of decreasing the pressure where breaks and slides might be expected, by excavation with steamshovels, has continued uninterruptedly since January, 1911. Three shovels have been kept continuously at work terracing the west bank at Culebra, and the same number were occupied during the latter part of 1911 on the opposite bank. The excavation has been made in each locality in a series of nine terraces. In addition, one shovel has been engaged in similar work at the Whitehouse yard, and another on the east bank, a little south of the Empire suspension bridge. The maximum depth of material removed at one spot in the west bank at Culebra was 80 ft., measured vertically, and on the east bank 70 ft. in one place.

The record shows that while the lightening of weight has, on the whole, been beneficial, it has not wholly stopped the moving and heaving. The results obtained so far, however, warrant a continuance of this work, and it will probably be prosecuted until all excavation in the cut by steamshovels has been completed.

Most of the so called slides during the past year, or more, were, properly speaking breaks in the banks of the cut, due to the inability of an underlying layer of rock of poor quality to support the enormous pressure superinduced by the weight above it. This weight crushes the underlying material, forces it laterally, and causes it to heave in the bottom of the cut.

Observations made show that the material at times has heaved to a height of 30 ft., but within the past year, or more, 15 or 20 ft. has been about the maximum height. Other observations made of these upheavals go to show that the material involved is not clay or stiff mud, as is commonly supposed, but rather argillaceous sandstone in pieces ranging in volume from a few cubic inches to 20 or 30 cu.yd., with an average perhaps of from 1 to 3 cu.yd.

The largest floating docks are said to be those at Kiel and Hamburg (Germany), which are respectively of 40,000 and 35,000 tons lifting capacity. A list of a number of large docks of this type is given in "The Engineer," of London, and includes the one recently built for Montreal, which was mentioned in the article on the Montreal harbor works in our issue of Nov. 9, 1911.

THE LARGEST FLOATING DOCKS IN THE WORLD

Dock	Lifting capacity Tons	Length Ft.	Clear width Ft.	Depth over keel blocks Ft.	Owners
Kiel	40,000	656	154	35½	German Govt.
Hamburg	35,000	720	108½	33	Blohm & Voss
Medway	32,000	680	113	36	British Govt.
Portsmouth	32,000	680	113	36	British Govt.
Montreal	25,000	600	100	27½	Canadian-Vickers Co.
Hamburg	25,000	525½	108½	33	Vulcan Co.
Pola	22,500	584½	111½	37	Austro-Hung. Govt.
Rio de Janeiro	22,000	550	100	30	Brazilian Gov.
Hamburg	20,000	511½	97	26	Reiherstieg Co.

Municipal Subway System for Chicago

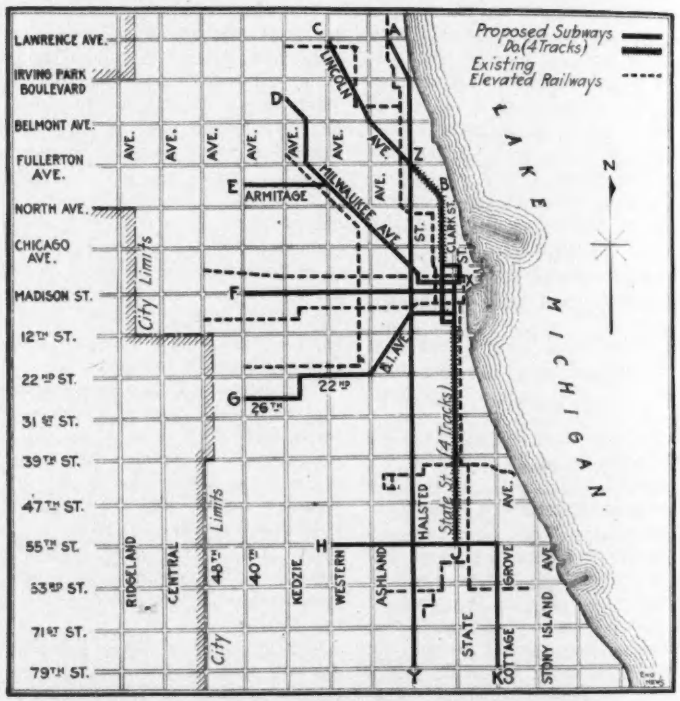
The city of Chicago has for several years proposed the construction of a subway system to improve its rapid transit facilities and to relieve the very serious congestion of traffic in the downtown district. The following article is an abstract of a recent report on the latest phase of the development of the project.

The latest step in the development of the project for a municipally owned rapid-transit subway system for Chicago, is in the form of a report recommending definite routes for a comprehensive system of subways. This report was presented Sept. 10 to the council committee on local transportation, having been prepared by the Harbor and Subway Commission in conjunction with a sub-committee of the above council committee. The proposed system is shown in the accompanying map, and the question of routes is now ready for submission to the City Council. The Harbor and Subway Commission is composed of John Ericson, James J. Reynolds and E. C. Shankland. Alderman Eugene Block is chairman of the sub-committee mentioned. In view of the present status of the project we give below a list of articles dealing with some of its earlier stages,* and elsewhere in this issue we have discussed the general aspect of the situation.

Early in 1912 it seemed likely that the elevated-railway companies would cooperate with the city's representatives in planning a subway system which would be auxiliary to and operated in connection with the elevated-railway systems, and serving especially the more congested sections of the city. The companies, however, abandoned this proposition, so that negotiations ceased, and the city proceeded with its plans for an independent municipal subway system. In February, 1912, the Harbor and Subway Commission (acting under specific instructions) submitted tentative routes, and subsequently it was instructed by the council committee on local transportation (and by the City Council on July 15) to present a comprehensive scheme of subways extending into the outlying districts, and being entirely independent of (and supplementary to) existing means of transportation. A trip was then made to inspect the subway systems of Boston, New York and Philadelphia, and following this the present report was prepared.

The report states that within ten years the average number of rides per capita on local transportation lines in Chicago (exclusive of suburban traffic on steam and electric railways) has increased from 200 to 300. Assuming that population will continue to increase in the same ratio as in the past, it is considered obvious that a comprehensive system of municipal subways is needed to care for new traffic besides relieving present congestion. The subway system now proposed is on a basis of permanent municipal ownership and control, providing rapid-transit trunk lines, with such through-route connections and outlying extensions as to unite the three divisions of Chicago into one unit. The system may be expanded further as conditions may require. The initial routes (shown on the map) are intended not only to relieve present congestion but to have sufficient capacity to handle the traffic of such feeders as may be provided in future to form an extension of the subway system. These initial routes are laid out along thoroughfares which are arteries of communication between dense groups of population. This will insure relief of traffic congestion, will shorten the period in which the profits from operation will be required to pay the capital cost, and will accelerate the growth and prosperity of sections of the city now suffering from poor transportation facilities. The demands of particular residence or business sections for subway routes were not allowed to affect the principle of locating subways which will accommodate the greatest number of persons and will give better intercommunication for the three divisions of the city.

The report states that the location has not been based on the theory that subways should be built only where they will yield immediate profit on operation (which theory largely governs the laying out of privately owned lines). While due weight has been given to the possibility of profitable operation in each case, the location has been based mainly on the principle of penetrating all sections of the city at the same time, thus tending to equalize the development of these sections. It is stated also that a muni-



MAP OF PROPOSED MUNICIPAL RAPID TRANSIT SUBWAY AT CHICAGO

(Dotted lines show the existing elevated railways. In earlier projects, designed mainly to relieve traffic congestion in the business district, the subways usually extended about a mile in each direction: to 12th (or 22d) St. on the south, Halstead St. on the west, and Chicago Ave. on the north).

*The following is a list of articles published in Engineering News dealing with various projects for a subway system for Chicago.—Editor.

Railway companies' plan; 1900; II, 85.
Project of W. H. Rosecrans; 1901, I, 88.
Projects of John Ericson (City Engineer), Geo. W. Jackson and others; 1902, II, 44, 65; 1904, II, 569; 1909, I, 600.
City projects; 1904; I, 279; 1906, II, 73, 79; 1909, I, 600; 1911, I, 644; 1911, II, 189, 602.
Project of Geo. W. Jackson; 1904, II, 569.
Project of B. J. Arnold (for the city); 1903 I, 16; 1906, II, 73, 79; 1911, I, 227.
Project of John Ericson (for the city); 1909, I, 600.
Project of R. C. St. John; 1909, II, 199.
Congested traffic conditions in Chicago; 1909, II, 199, 201.
Review of the street railway history of Chicago; 1910, I, 267.
Projects of B. J. Arnold and A. S. Robinson; 1911, I, 227, 489.
Project of Subway Commission; 1911, II, 189, 602.

cipally owned system can afford to support (for a time) the less profitable extensions out of the surplus earnings of the more profitable lines.

Construction and Equipment

In the planning of the subways themselves simplicity has been aimed at, to combine the least expensive methods of operation with the most effective means of providing rapid transit. The principle has been to provide high-level subways, as close as possible to the surface of the street; the only deviations from this principle being at intersecting points and river crossings. It is considered that this will give lower cost and greater efficiency than a low-level system. For ventilation, it is proposed to utilize the piston action of trains, each track being separately inclosed, except at stations. Suitable openings for air circulation will be provided in the roofs and sides of the subways. This natural ventilation will be supplemented by means of exhaust fans placed in chambers between the stations, to be used in case of excessive heat or other abnormal conditions.

The power system comprises alternating-current generation and distribution, and 625-volt direct-current operation of motors, using the third-rail system of conductors. All cables between the power house and substations to be in underground conduits, which are to be built as part of the tunnel walls when the cables parallel the subway. Automatic block signaling and interlocking plants are included. The cars proposed are to be of steel construction, seating 60 passengers each, and equipped with electric light and heat. They are to have high-power motors to insure high schedule speed with frequent stops, and trains will be operated on the multiple-unit system.

As to public utilities, the accommodation of municipally owned utilities is under consideration, but no definite plans can be made until the routes are decided upon. On this point the report states as follows:

"In some cases it may be advisable to construct a compartment for this service, but generally the utilities may be diverted or placed in sub-surface space not required for subway use. Conferences with public-service corporations indicate a preference upon their part to move to other territory and to build and maintain their own conduits, rather than to pay their proportion of the cost of a compartment in the subway. In Boston and New York no provision has been made in their subways for either municipal or private utilities. The utilities were either put in the sides of the streets, or under the surface of the streets over the subways, or else (as was done in many cases) they were diverted to adjoining streets."

Cost

The total cost is estimated at $96,257,000 for construction and $34,844,000 for equipment, or $131,101,000 in all. The total length of the system is 56.4 miles; all of this is double track, except 9.4 miles of four-track. Thus the construction cost would average a little under $2,000,000 per mile of double-track subway (66 miles). The 12 miles of double-track line on Halsted St. (79th St. to Fullerton Ave.) average $1,600,000 per mile. The equipment will be furnished by the operating company. No details of cost are given in the report and the total is simply divided as follows:

N. side lines to Lawrence Ave.	$20,123,000
S. side lines to 79th St.	25,778,000
W. side lines to 40th Ave.	31,049,000
Halsted St. line, 79th to Fullerton	19,307,000

The estimate includes the following: 1, excavation and bracing; 2, concrete, brick and steel construction; 3, shoring and bracing of buildings; 4, restoration of street paving and tracks; 5, temporary construction to maintain sewer and water service and fire protection during obstruction; 6, maintenance of limited or controlled traffic in half the width of streets within three miles from the center of the down-town district. Beyond this distance it is expected that traffic may be diverted.

Traffic

The traffic capacity of the entire system of 56½ miles is estimated at 180,000 seats per hour. The accompanying table shows the length of the several routes from the center of the business district, with the number of station stops, and the estimated time of the trip from the outer terminal to the business center. The letters indicating the routes refer to the accompanying map; *X* signifies the center of the business district.

It is intended to adopt the principle of a 5c. fare from any one point to any other point within the city limits (including transfer), and the report points out that all the new subway contracts in New York are based on a universal 5c. fare. It is considered that this will be the speediest method of wiping out the artificial barriers between the three divisions of the city.

PROPOSED MUNICIPAL SUBWAYS FOR CHICAGO

Route	Miles	No. of Stations	Min. for trip Exp.	Local
A-B-X. Evanston Ave., Clark St.	6.5*	13	18.7	21.8
C-B-X. Lincoln Ave., Clark St.	7.0*	14	20.4	23.5
D-X. Elston & Milwaukee Aves.	7.7†	16	....	26.3
E-X. Armitage & Milwaukee Aves.	7.1†	15	....	24.0
F-X. Madison St.	4.8	10	....	16.3
G-X. 26th, Blue Id. Ave., Harrison St.	6.8	14	....	23.0
H-J-X. 55th and State Sts.	9.0‡	20	25.7	31.4
K-J-X. Cott. G. Ave., 55th and State	10.1‡	22	29.3	34.9
Y-Z. Halsted St. (79th to Fullerton)	12.0	24	....	40.2

Total (subtracting 14.6 miles of duplicated line, as below; 56.4 miles.

*3.4 miles of four-track, common to routes A-X and B-X.

†5.2 miles of double-track, common to routes D-X and E-X.

‡6.0 miles of four-track, common to routes H-X and K-X.

Financing

The report discusses methods of financing the project by the city itself and by private enterprise (the city retaining ownership and control in any case), and states as follows:

"The scheme has been worked out on the proved theory (based on New York's experience) that the capital cost of construction can be provided for in full out of future earnings, and that no part of such capital cost need form an additional ultimate charge upon Chicago's taxpayers. * * * It may be set down as a fixed principle that the financing of an independent system of municipal subways should only be undertaken on such terms as will automatically wipe out the capital cost of such subways, in a given term of years, on a sinking-fund basis, and will make certain that at the end of such term the entire subway plants shall become the property of the people of Chicago, free of all debt."

Building by the City—As to the suggested method of building the municipal subways out of the proceeds of legalized Mueller certificates, the Corporation Counsel has stated: 1, the city has power to issue bonds for the construction and equipment of subways, provided that they are a lien upon such property and income only, and are not included in the city's bonded debt; 2, it has the right to pledge and pay the present traction fund* as interest upon such bond issue, and to use this fund for funding the bonds; 3, it has the right further to use any revenue from the operation or leasing of such subways for the purpose of retiring these bonds.

Private Capital—An alternative method of financing the project is to prepare plans and specifications for a definite group of initial subways and to invite competitive bids for construction, under limitations which will insure not only municipal ownership but also municipal control until the extinction of the capital debt. Bids may be asked on alternative methods, as follows: 1, construction only; 2, construction, maintenance and operation; 3, maintenance and operation. This arrangement would enable special construction agencies or special operating agencies to make separate bids. If a contract is made with an operating company, there should be no division of surplus profits from operation (after providing for necessary fixed charges) until regular payments into a sinking fund have been provided for.

The report states that better terms under this system of competitive bids

*This fund is derived mainly from the percentage of receipts which the street railway companies now pay to the city, under the ordinance of 1907, and now amounts to about $10,000,000. The companies pay 55% of their net profits (in excess of operating expense and 5% interest on capital investment.

can be secured in Chicago than those obtained in New York, where (for extensions to cost $250,000,000) about 50% of the construction capital is furnished on municipal credit and 50% by the companies. The New York contracts provide that the city will assume absolute control of all the new subways and reserve the right after ten years to "recapture" any or all lines for combination in an independently operated or municipally operated system.

Preliminary Treatment of Water for Slow Sand Filtration at Pittsburgh, Penn.

By George A. Johnson*

On July 8, 1910, the writer was appointed by Mayor W. A. Magee to review all available data bearing on the operation of the Pittsburgh water filtration plant, and after a personal study of the situation to report on ways and means of obtaining from these works as large a volume of filtered water as was commensurate with satisfactory quality and reasonable cost of operation.

As a result of his preliminary studies it became apparent that, among numerous other things, there was urgent need of correcting the acid and iron conditions in the river water, and providing means whereby the existing sedimentation reservoirs would be rendered more efficient, so that there might be delivered to the filters at all times a water which they could handle efficiently and economically. Accordingly, on July 19, 1910, on the writer's recommendation, Robert Spurr Weston, of Boston, was appointed as his associate, Mr. Weston's duties being to thoroughly study the chemistry of the Allegheny River water, and with the writer to formulate plans whereby those objectionable features above referred to, which have such a controlling influence on the proper operation of the filtration plant, might be overcome.

The Allegheny River is made up of two main streams, the Allegheny proper and the Kiskiminetas. The latter drains a coal-mining region, and consequently is charged with wastes highly acid in character. The action of these acid wastes on the rocks results in a decomposition thereof, forming streams containing silicates and sulphates of iron, aluminum, manganese, calcium and magnesium; also free acid. As these contaminated streams become diluted with the normally alkaline water of the main stream the sulphates of iron, aluminum and manganese decompose, liberating hydrates of these metals, as well as sulphates of calcium, magnesium and other bases. Some of these bodies exist in colloidal or semi-soluble condition, and do not precipitate until mixed with the Allegheny proper, or later when the water is filtered through sand.

The Allegheny River is radically different in character. It is alkaline and never acid, is moderately turbid, and drains an oil-producing, agricultural and manufacturing region. It contains considerable finely divided clay, tannery and distillery wastes, highly colored water from swamps, and also oil and paraffin.

At certain times the Kiskiminetas River gives character to the raw water received at the filtration plant; at other times the Allegheny. On some occasions the raw water will be acid; on others the alkalinity will be high. Sometimes the main stream is practically without turbidity; at other times the turbidity reaches 2500 parts per million. At most times of the year during calm weather a coating of oil or paraffin floats on the surface of the river.

The two streams come together at a point some 20 miles above the filtration plant, and for this distance the river is practically a large sedimentation basin. Were the two streams mixed in proper proportions at all times the resultant water would be admirably suited to filtration, through the coagulating and precipitating action produced by the admixture of the acid wastes of the Kiskiminetas and the turbid alkaline waters of the Allegheny. But this is rarely ever the case, as before stated, and the changes in the character of the raw water at the filtration plant are many, frequent and varied.

Because the river acts in a measure as a settling basin further sedimentation in the relatively small settling basins at the filter plant results merely in settling out the coarse particles when the tur-

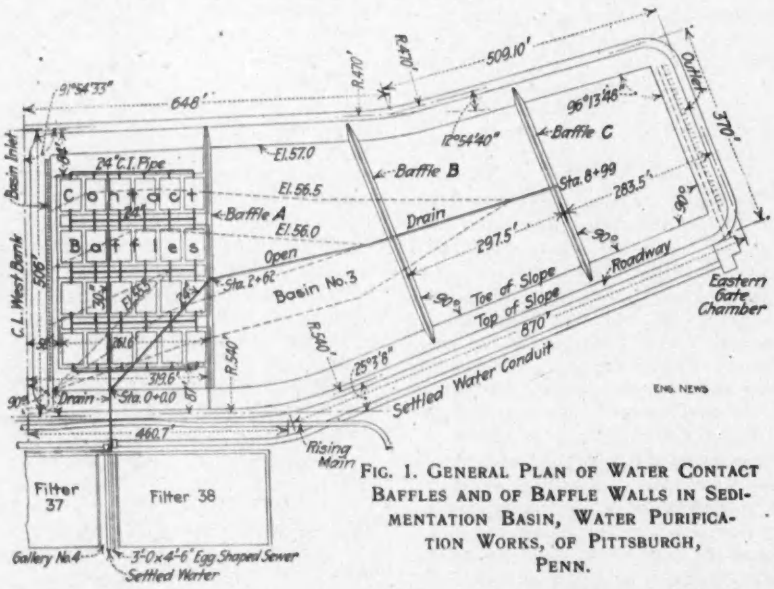


Fig. 1. General Plan of Water Contact Baffles and of Baffle Walls in Sedimentation Basin, Water Purification Works, of Pittsburgh, Penn.

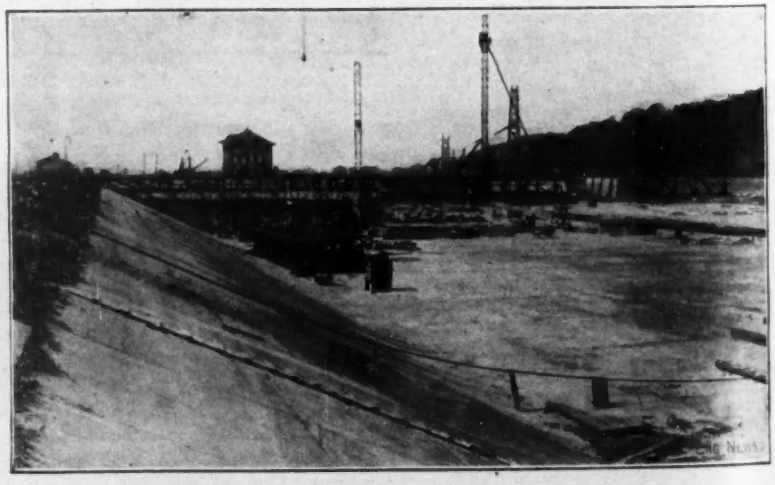


Fig. 2. General View, Basin No. 3, Looking Northwest

*Johnson & Fuller, Consulting Engineers and Sanitary Experts, 150 Nassau St., New York City.

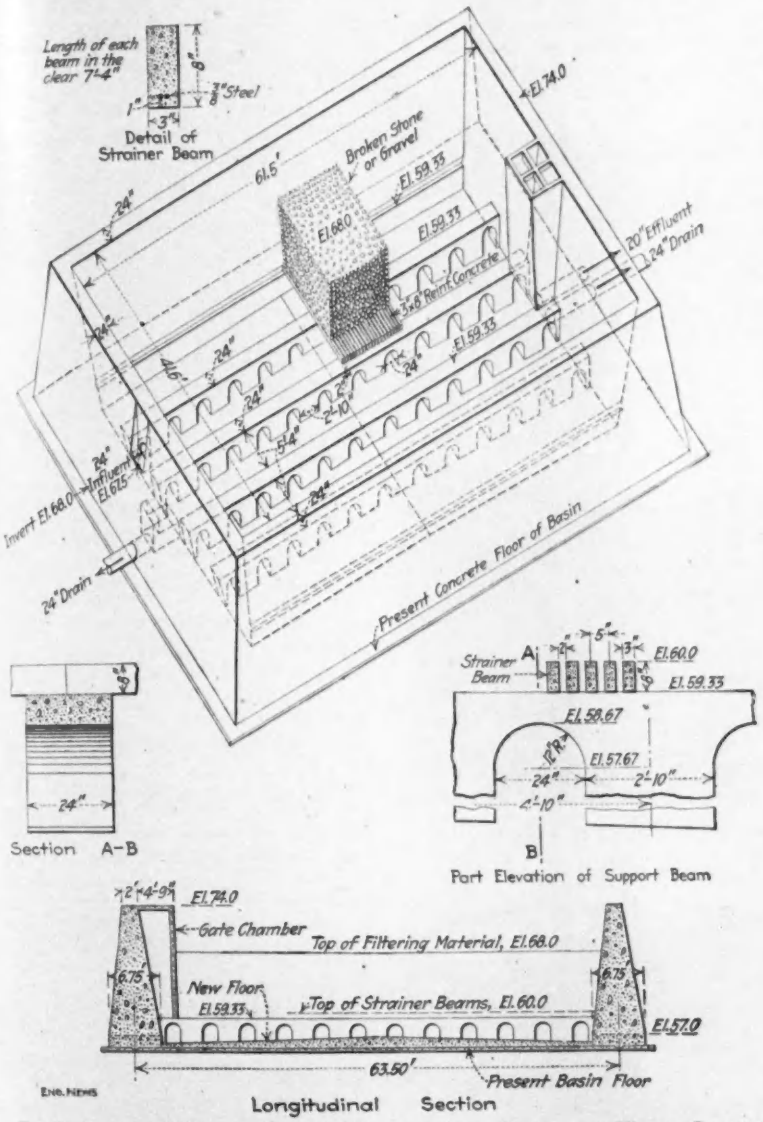


FIG. 3. ISOMETRIC VIEW OF TYPICAL UNIT AND SOME DETAILS OF WATER CONTACT BAFFLE, PITTSBURGH, PENN.

bidity is high, leaving behind the troublesome fine material. There is little action in these basins when the turbidity is low.

The rapid clogging of the filters, whereby their average net capacity is materially lowered, is due as a general proposition to incomplete precipitation of the results of the mixing of two or more chemically unlike streams, complicated by the presence of oil and influenced by temperature. The most serious condition is where the whole top surface of the sand cements together. In these cases the clogged layer is sometimes as much as 4 in. thick. It slowly hardens on drying and frequently becomes difficult to break with the fingers, and contains paraffin-like bodies, silicates, iron, aluminum, manganese, calcium, magnesium and organic matter.

As a result of experimental studies extending over a period of more than one year it was found that the most efficient manner in which the raw water could be properly prepared for filtration through the existing filters was by adding certain chemicals, either singly or in combination according to the character of the river water, and then passing the chemically treated water through contact baffles, or beds, of gravel, the resulting effluent to then be passed through the existing sedimentation reservoirs in which, to increase their efficiency, A-frame baffles would be placed.

The chemicals required to treat the different kinds of water encountered during an average year include sulphate of alumina, lime, clay and bleaching powder. Prolonged study showed that each has its particular field of usefulness.

The contact baffles are necessary for the reason that, with the existing arrangement of the purification works, insufficient time is available for complete reaction of the added chemicals with the water, and for adequate sedimentation. It is the contact with inert material (sand) which now causes the coagulation of colloidal matter at the surface of the sand filters; consequently, by passing the water over the coarse materials which the contact baffles contain, coagulation is brought about more swiftly and most of the objectionable matter is retained in the baffles and basins before the water reaches the filters. For about one-half of the average year, according to present evidence, it will be necessary to add chemicals to the water before it is applied to the contact baffles. For the rest of the year the raw water may be applied to them without previous chemical treatment.

As shown by Figs. 1 to 6 the contact baffles are being built of concrete, in tank form, and divided into units of about 60 ft. by 40 ft. A total area of 1⅓ acres will serve for a minimum filtering capacity of 100,000,000 gal. daily. The contact material is gravel, ranging in size from ½ to 1 in., and the depth of the layer is about 8 ft. The treated

FIG. 4. VIEW OF CONTACT BAFFLES, UNDER CONSTRUCTION; LOOKING SOUTHEAST

water will be allowed to flow from the small middle reservoir onto the surface of the contact baffles, and the beds, when clogged, will be cleaned by shutting down one unit at a time, opening the drain and allowing the water standing over and in the bed to rush out, carrying with it to the sewer the material which has accumulated within it.

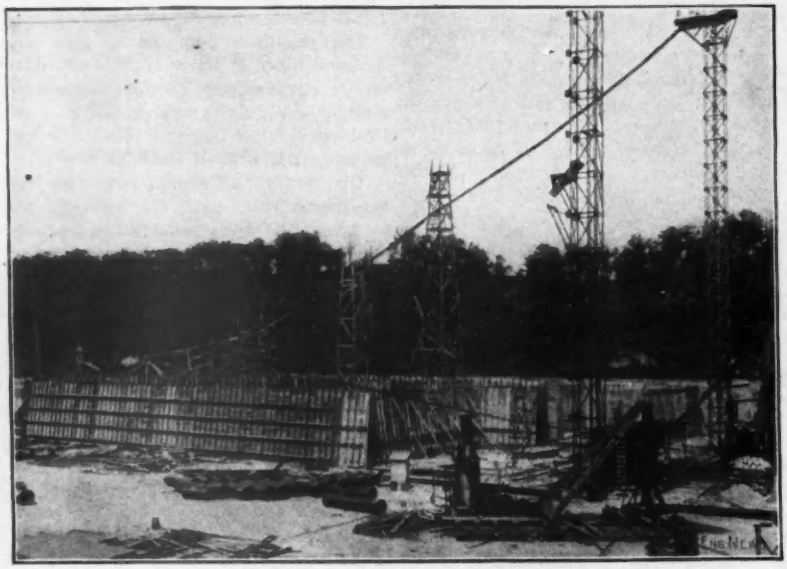


FIG. 5. VIEW OF CONTACT BAFFLES, UNDER CONSTRUCTION, LOOKING NORTHWEST

The false bottoms (for which see details, Fig. 3) with which the contact baffle tanks are provided will facilitate the thorough cleaning of the beds. It will be noted that the contact gravel is supported by reinforced-concrete beams, with spaces between them to permit the water to flow readily into the chamber below.

The A-frame baffles (Figs. 7 and 8) are built of concrete beams, 9x9 in. in section, well reinforced with metal. The beams are mitered together at the top, and tied together by means of a concrete cap, also provided with heavy rod reinforcement. The latter is 9x28 in. in section and fits over the top of the concrete A-frames, holding them securely in position.

On setting up the A-frame beams the foot of the beam is secured in position by drilling a hole in the reservoir bottom and inserting an iron rod which will extend into the foot of the beams. This rod is then grouted firmly into position. The reinforced-concrete slabs which rest against the concrete beams are 4 in. thick, about 8 ft. wide and 8 to 12 ft. long, and are reinforced with expanded metal.

There are doors between all of the A-frame baffles at the place where the sludge drain passes through them. The purpose of these doors is to allow men to go from one compartment to another as they are cleaning out the sludge. The doors are of cast iron, hinged on one side, and are about 2 ft. wide and 5 ft. high.

The experimental studies were carried on at the Ross Experiment Station, which was in charge of Ralph E. Tarbett. The analytical work was done under the direction of W. U. C. Baton, analyst in the filtration division. Chester F. Drake, superintendent of filtration, had charge of the design of the baffling arrangements.

All of the construction work, from first to last, was carried on under the immediate supervision of Chas. A. Finley, superintendent of the Pittsburgh bureau of water.

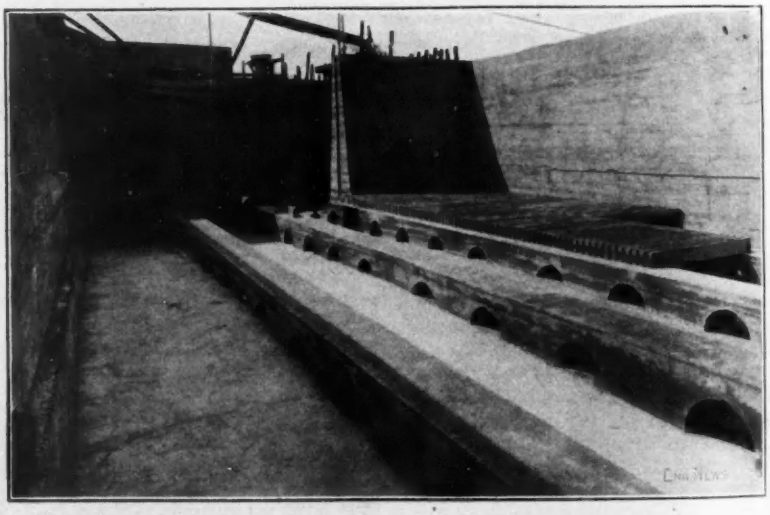


FIG. 6. INTERIOR OF BAFFLE UNIT 19; GRAVEL REMOVED

Elimination of Dust from Portland-Cement Plants

The control of dust in portland-cement manufacture by the Cottrell precipitation process was described by W. A. Schmidt, of Los Angeles, Calif., in a paper before the recent International Congress of Applied Chemistry in New York City, Sept. 6. (The Cottrell process as adapted to the precipitation of suspended matter in smelter fumes was described in ENGINEERING NEWS, Oct. 26, 1911. It will be recalled, from this article, that the burden of suspended matter is swept out by high-tension direct-current discharges playing between two series of electrodes set in the flue passages.)

It was stated, in the above paper, that a rotary kiln 100 ft. long, 7 ft. in diameter, oil-fired, as on the Pacific Coast, discharges 50,000 cu.ft. of stack gases per minute, at a temperature of about 450° C. and carrying between 4 and 5 tons of dust per 24 hr. In an installation at the Riverside Portland Cement Works, in California, the deposition section is 12x16 ft. and 20 ft. long. The apparatus is placed on a platform at a height of 80 ft. above ground, and upon this is placed a short stack extension going to the roof of the kiln building and supplied with a special damper. On either side of the stack is a complete deposition installation separated from the stack extension by a large louvre damper. The gases can be conducted through either or both of the treating chambers, or thrown directly into the atmosphere, if necessary. Under normal conditions the gases pass through both treaters, but in case one should be shut down for repairs, etc., the other will take care of the gases with moderate efficiency. Each apparatus has a small outlet stack 20 ft. high sufficient to compensate for the re-

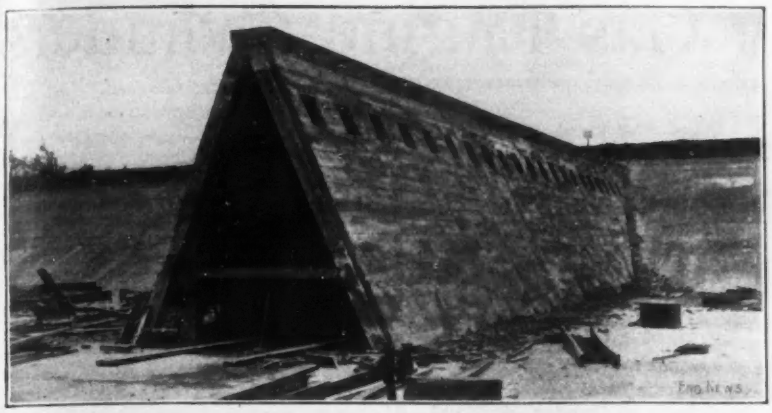


FIG. 7. A FINISHED SECTION OF A-FRAME BAFFLE, PITTSBURGH WATER SEDIMENTATION BASIN

sistance offered by the apparatus. There is no change of temperature in the kilns or stacks when the gases are thrown into the air directly or passed through the treater.

The electrodes are placed 6 in. apart, and there are twenty rows of discharge electrodes in series. The collecting electrodes are cleaned once every three or four hours by mechanical rapping. This is done by the operator throwing an electric motor into operation. The dust falls into hopper bottoms and is collected and conducted into bins feeding the rotary kilns. A complete installation of this size consumes about 7.5 kw., including energy for all motors. A 5000-bbl. mill would consume about 75 kw. for the entire installation. One man per shift is required of the grade ordinarily employed for running electric mill machinery. It is advisable, however, to have an extra man on duty. There is no deterioration in the apparatus on steady running, and it is subject to exactly the same wear as any other piece of electrical machinery.

There appears to be some possibility of using the collected dust as a source of potash for fertilizer. The Riverside plant uses a decomposing feldspar in the place of clay in its raw mix. In burning the cement, the potash is volatilized and condenses again in passing up the stack. The greater part is caught in the precipitation apparatus along with the dust, and gives the latter a considerable percentage of potash. Experiments have been conducted, looking toward the utilization of this material either directly or by extraction of the potash, but the work is not sufficiently advanced to give definite figures.

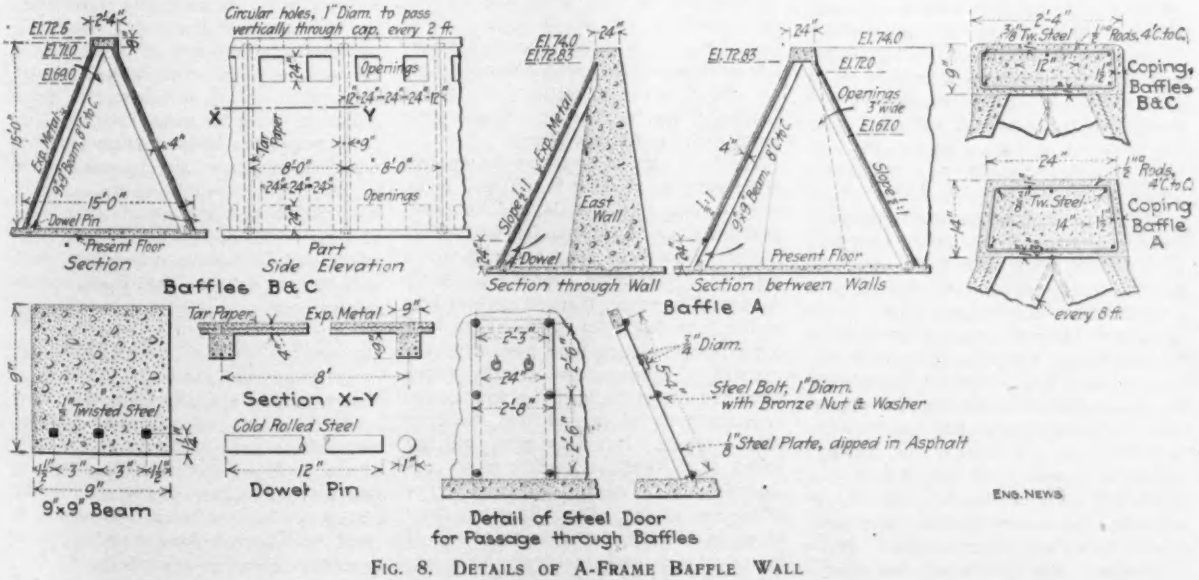


FIG. 8. DETAILS OF A-FRAME BAFFLE WALL
(See Fig. 1 for location of Baffles A, B and C).

A Uniform Basis of Rates for electricity supply has recently been prescribed by the Wisconsin Railroad Commission for the Milwaukee companies. The order is the result of complaints of discrimination and disclosures that at least one company permitted manipulation of its schedules to give prospective customers lighting service at the lower motor-service rates. Moreover, a number of individuals had been grouped on one bill and fixtures has been furnished free or at nominal expense.

Rates are ordered computed on the basis of a demand charge; this is $42 per year for each kilowatt of demand up to 10 kw., $30 up to 60 kw., and $24 in excess. The demand charge is payable in equal monthly amounts, being added to an energy charge of 4c. per kw.-hr. for up to 1000 kw.-hr. This figure drops to 3c. for the next 3000 kw.-hr., to 2c. for the succeeding 6000 kw.-hr., and to 1.5c. for all in excess of 10,000 kw.-hr.

Electricity-supply service has been classified as "lighting," "power" and "combined." The first has been defined to include furnishing energy for illumination, small motors and miscellaneous appliances when the starting current is limited to 2½ times full-load current; alternating-current motors up to ¼ hp. for 110 volts, and ½ hp. for 220 volts are permitted, as are 1-hp. direct current. The aggregate rated capacity of motors and miscellaneous appliances, however, is not to exceed 2 kw., and must not exceed the aggregate rated capacity of the lighting equipment.

Power service has been defined to include furnishing energy for motive power and heating, but miscellaneous lighting is included when the lighting demand does not exceed 20% of the total.

It has been provided also that the maximum rate for electric lighting service in any one month shall not exceed 10c. per kw.-hr. for the first 200 kw.-hr., 8c. for the next 200 kw.-hr., 6c. for the following 200 kw.-hr., and 4c. for all over 600 kw-hr. Power service is permitted at an optional rate of 6c. per kw.-hr. for the first 200 kw.-hr., 5c. for the next 200 kw.-hr. and 3c. for all over.

Fixtures and appliances are not to be sold by the electric companies at less than cost plus 6%, but the companies may rent equipment at rates equal to cost of repairs, interest and depreciation.

Heat Flow in Gas Engine Cylinders

Many important problems in gas and oil engine design have to do with the heat generated inside the engine cylinder, which is in fact the source of the engine's power. Formerly little was known definitely concerning this heat generation and it was the subject of much speculation and many false theories. At the recent meeting of the British Association for the Advancement of Science at Dundee, Scotland, there was presented before the engineering section the fifth report of the Association's Committee on gaseous explosions, of which Mr. Dugald Clerk is chairman. The report sums up the best scientific knowledge at the present day, as to what goes on inside a gas engine cylinder.

In this report the Committee propose to give a short review of the present state of knowledge with regard to the heat flow from the working substance of a gas engine into the cylinder walls.

The rate of flow of heat from the gas to any part of the walls, at each instant of time, depends upon the then state of the gas as regards temperature, density, and motion, and also on the temperature and condition of the wall surface. It differs widely at different points of the expansion stroke, being far greater just after firing, when the gas is at a high temperature and highly compressed, than toward the end of expansion. There will, however, be a certain mean rate of heat flow into any patch of the cylinder walls, and heat must be conducted from that patch, on the whole, as fast as it goes in. In order that the heat may be conducted away at the required rate, there must be a certain temperature gradient in the metal, and there will be a corresponding mean surface temperature. Superposed on the mean surface temperature are variations due to the varying rate of heat flow at different parts of the cycle. The thermal conductivity and capacity for heat of cast iron are, however, so large that these variations on a clean metal surface must be small—a conclusion which has been verified by Coker, who found a maximum cyclical change of but 7 deg. Cent. at a depth of 0.015 in. in the wall of the combustion chamber of an engine running at 240 revolutions per minute. If the metal surface is not clean the variation at the surface of the carbon or other deposit may be much greater.

The important practical question is the mean rate at which heat goes into each part of the surface, and the resulting mean distribution of temperature. The chief problem in designing large gas engines is to control the mean temperature distribution by water-jacketing or otherwise in such a way that the metal does not get overstrained by unequal expansion nor reach a temperature sufficient to ignite the gas. The temperature gradient necessary to sustain the flow of heat from the inside of a combustion chamber to the external water is not likely to exceed 50 deg. Cent. per inch. At places where the metal is not thick and effective external circulation of water is possible cooling does not present great difficulty; but at places which are not near to the cooling water, so that the heat has to travel a long way, the temperature must be high to give the necessary gradient. Thus the central portion of the head of an ordinary flat-faced piston, if not water cooled, gets very hot, reaching a temperature of perhaps 600 deg. Cent. in a four-cycle engine of 24-in. bore. The piston expands considerably in consequence, the expansion being greater at the center than at the edge, which is accordingly put into tension. In larger cylinders the stresses in the piston set up by unequal heating and the danger of preignition arising from the hot metal necessitates the cooling of this part by the circulation of oil or water. Even then the great thickness of metal in certain portions of the combustion chamber and the difficulty of keeping the water flowing properly in every corner may cause high local temperatures.

The heat carried away by the cooling water and by radiation is the total given to every part of the walls, and its measurement gives no information on the important question of the manner in which the flow is distributed over the walls. It is certain, however, that the greater part of the heat flow in a cycle occurs in a comparatively short time just after the moment of ignition, and passes, therefore, into the surface of the combustion chamber and valves and into the face of the piston. But little goes into the barrel of the cylinder, which is not uncovered until the density and temperature of the gases have fallen. That this must be so is obvious, but the magnitude of the effect is perhaps not generally recognized. Dugald Clerk found in his experiments on the compression and expansion of flame* that the average heat flow per square foot per second in the first three-tenths of the stroke is three times that of the average over the whole stroke for equal temperature differences, and he calculates that the actual rate of heat flow in the first three-tenths is six times that of the whole stroke in ordinary gas engines working at full load. This estimate, however, does not include loss due to radiation before maximum temperature. In the actual firing and expansion stroke of a gas engine the difference must be even more when radiation an' other losses, incurred before maximum temperature, are included, and it is probable that, in discussing the problem of cooling the metal, it is a sufficiently good approximation to neglect the heat flow into the outer half of the barrel altogether. Professor Hopkinson informs the Committee that he has worked a gas-engine cylinder of over 30 in. diameter in which there was no water circulation round the barrel at all. The whole of the heat passing into the barrel was in this case removed either by radiation or by conduction into the piston, nor was the cooling which was applied to the piston much more than that found necessary on other parts of the walls of the combustion chamber. In small engines with uncooled pistons the water jacket round the barrel is necessary to keep the piston cool.

In the scientific analysis of gas-engine phenomena the facts stated in the last paragraph are important because they show that the heat flow is not much different from that which would occur in a closed vessel of invariable volume having the form and size of the combustion chamber, the mixture fired having, of course, the same composition, density, movements, etc., as in the engine. Some allowance must be made for the fall of temperature and density which occurs in the initial stages of the expansion in the engine, but this will be of the nature of a correction, and will not affect the value of the general conclusions as to the effect of the various factors in heat flow which may be drawn from closed vessel experiments.

The Factors in Heat Flow

1. *The state of the walls*—The loss of heat following a gaseous explosion in a confined space depends partly on the state of the gas and partly on the state of the walls of the inclosure. Dealing first with the walls, it is obvious that the higher the surface temperature the less rapid will be the flow of heat, which, generally speaking, depends on the difference of temperature between the gas and the surface. If the metal surface be clean, the surface temperature cannot rise by more than an insignificant percentage of the temperature difference; but if it be coated with a nonconducting layer the exposed surface may be heated by the first rush of heat after ignition to such an extent as materially to check the subsequent flow.

2. *Radiation from the gas*—Of more scientific, though perhaps of less practi-

*Proc. Roy. Soc., A., Vol. 77 (1906), p. 500.

cal interest, is the reduction in heat loss, which is found when the walls are highly polished. This is due to the fact that radiation is an important, if not the principal agent, in the transfer of heat from the gas to the metal. This matter was dealt with in the third report of the Committee, and it is unnecessary to recapitulate the results there given. It has, however, been carried a good deal further by the researches of W. T. David, who has investigated the relation between the amount of the radiation and the mean temperature of the gas. He finds that the rate of loss from this cause varies roughly as the fourth power of the absolute temperature.

In a closed vessel explosion the rate of heat flow diminishes with very great rapidity as the gas cools down after ignition. One cause of this is the fact that when the flame first touches the walls the heat is drawn almost wholly from the surface layer of gas in contact with them, and the flow is at first extremely rapid. This surface layer soon parts with its heat and further supplies have to be drawn from the inner portions of the gas, the cool surface layer now acting as heat insulation. But it is probable that the rapid reduction in radiation as the temperature falls is quite as important a factor in this phenomenon. In the gas engine it is, of course, accentuated by the reduction of temperature consequent on expansion. The closed vessel experiments lend confirmation to the view already expressed that in the gas engine the rate of heat flow per unit of area has fallen to a comparatively small value when the piston has moved a short distance out on the expansion stroke.

An important practical consequence of radiation is the greatly increased loss of heat which occurs when the mean pressure in an engine is increased by increasing the strength of the mixture. The jacket loss and the metal temperatures are raised in a much greater proportion than the fuel consumption, and the efficiency is diminished. In very large engines this sets a fairly sharp limit to the possible output, which is, as a rule, considerably less than the maximum of which the engine would be capable if it were given all the fuel that it could take. If the load be in excess of this limit the engine overheats rapidly in consequence of the greatly increased heat flow.

3. *The effect of cylinder dimensions on heat flow*—At first sight it might appear that heat flow is a surface phenomenon—that is, the number of calories per square centimeter per second passing into the walls of an engine or explosion vessel containing a gas at a given temperature and density should be independent of the volume. This view, which is rather widely held, is, however, certainly erroneous, and probably to a considerable amount. The effect of radiation is necessarily to make the heat loss per unit area from a large volume greater than that from a small volume, because the walls receive radiation from the inner layers as well as from the portions nearer to them. At some depth, of course, the radiation will cease to be sensible, and when that has been reached the radiation from the whole mass will not be increased by further increasing its volume. The experiments of David, to which reference has been made, show that the transparency of the products of an explosion while still at a high temperature is very great, and lead to the conclusion that the heat loss per unit area from a mass of glowing gas would go on increasing with the volume of the mass until that volume is comparable with the largest sizes of gas-engine cylinder now made. David found that the radiation after an explosion in a cylindrical vessel 1 ft. by 1 ft. was nearly twice as great when the walls of the vessel were highly polished as when they were black. The effect of completely polishing the interior of a vessel is, so far as radiation is concerned, much the same as greatly enlarging the volume of inclosed gas, so that this experiment gives an idea how far the heat loss from the gas in a cylinder 1 ft. in diameter falls short of that in a very large cylinder. It is quite clear that in a 12-in. cylinder the limit of size beyond which heat loss per square foot does not increase is far from having been reached.

One practical aspect of this question is the relation between size and thermal efficiency. This was fully discussed by Callendar in a paper read before the Institution of Automobile Engineers in 1907,* who pointed out the probability that some part of the radiation loss was proportional to the volume. If heat loss were simply a question of the surface exposed the percentage losses in similar engines should be reduced in proportion to the linear dimensions, and there should be a corresponding increase in efficiency. But in so far as heat flow increases with the volume, the efficiency of large and small engines will become more nearly the same. Of even greater importance practically is the absolute amount of heat flow per square foot, since it is this which determines the internal temperatures and so sets a limit to the output of the engine. The results cited show broadly that this quantity must be considerably greater in an engine of, say, 3-ft. bore than in one whose cylinder diameter is only 1 ft., and that the difficulty of designing and working the first is not alone due to the greater thickness of metal, but also to the greater heat flow.

4. *The effect of density*—The density of the gas in a gas-engine explosion is from four to seven times that of the atmosphere. In the Diesel engine it is, of course, very much greater. The effect of this factor is greatly to increase the heat flow as compared with an ordinary closed vessel explosion, where the density is that of the atmosphere and the vessel similar in size and shape to the combustion chamber. A rough notion of the magnitude of this effect can be obtained by comparisons of the jacket loss in a gas engine when the total quantity of combustible mixture is altered by throttling or otherwise, the composition remaining the same. It has been found that the total heat carried away from the jackets increases with the quantity of mixture, but not quite in proportion thereto.

The relation between heat loss and density in an explosion vessel is dependent upon two factors—namely, radiation and direct surface loss by convection and conduction.

The most important practical question connected with the relation between density and heat loss is the effect of degree of compression on the working and efficiency of gas engines. To put the matter in its simplest form we may suppose that the engine has a cylindrical combustion space and flat-headed piston, so that the inclosure containing the gas at the moment of firing is a cylinder. The length of this cylinder will in most cases be a fraction of the diameter, the ratio of diameter to length being of the same order as the compression ratio of the engine. The problem, then, is to determine how the amount and distribution of heat loss to the walls is altered when the compression ratio of the engine is changed, say, by lengthening the connecting-rod. In the ordinary case of a fairly high compression ratio the effect of this alteration will be to reduce the length of the cylindrical combustion space without changing its diameter and to keep the mass of gas confined therein substantially constant, so that the density goes up in inverse proportion to the length of the space. At the same time, there will be a small rise in the temperature of the fired mixture, consequent on the higher temperature before firing. This, however, would not be very much, amounting to about 100 deg. Cent. for an increase in compression ratio from 4 to 6.

The average heat loss per square foot to the surface will increase, but not in proportion to the density. On the other hand, the area over which that loss is distributed is reduced, but again in a considerably less proportion than the density. For instance, with an engine of equal stroke bore ratio, having a cylindrical combustion chamber, the result of increasing the compression ratio from 4 to 6 will be to reduce the surface of the combustion chamber by nearly 16 per cent. The density is, of course, increased 50 per cent., and if the heat loss increases in a greater ratio than the square root of the density, which is almost certainly the case, the effect of this increase of

*Proc. Inst. Aut. Eng., April, 1907.

compression would be to increase the total heat loss, and, therefore, to diminish the efficiency of the engine relative to the air standard. This in the case supposed would not, of course, lead to any reduction in actual efficiency, because the greater heat loss would be more than counterbalanced by the increase in the efficiency due to increased expansion. But it is clear that, if the process were carried sufficiently far, the absolute efficiency might also be reduced. Some approach to this state of things was found by Burstall when the compression exceeded about 7.*

The conclusion gained from practical experience that there is a point beyond which it will not pay to increase the compression in the gas engine is, therefore, in full accord with the results of laboratory experiments on the relation between density and heat flow. Not only is there a point beyond which increasing compression is not followed by an increase in efficiency, but before that point is reached the flow of heat per unit area is increased to an amount at which trouble will begin to arise on account of the difficulty of cooling. It is sometimes supposed that the difficulties which arise from preignition when the compression is increased too far are due in some way to the rise of temperature of the gas consequent on the high adiabatic compression. It is very improbable, however, that this has much to do with the matter. The real cause of preignition is the overheating of some part of the interior surface of the metal or of a deposit thereon, due to excessive heat flow following an increased density. If the metal could be kept clean and cool, compression could be carried to very much higher values than are now used in practice without any danger of preignition.

The effect of increasing density on heat loss is, however, a matter on which further experimental evidence is needed. A comparison of the rates of loss after explosions in a series of cylinders of the same diameter but of different lengths, the density of the mixture fired being varied in inverse proportion to the length —so as to keep the total quantity constant—would be of great interest. Such a comparison would throw direct light on the heat flow in an actual gas engine if among the cylinders tried were some in which the length was a fraction—say, one-sixth to one-third—of the diameter. In many gas engines the shape of the combustion space is approximately of this character.

5. *Turbulence*—During the suction stroke of a gas engine, or during the period of injection in an engine charged from a separate compressor, the mixture of gas and air which is subsequently to be exploded enters the engine through the valves or ports at a high velocity, so that the gas within the cylinder is in a state of eddying or turbulent motion. This motion gradually dies away after the valves are closed, but will persist for some time during the compression stroke, so that at the moment of explosion there may still be a good deal of turbulence. In consequence of this motion of the gas, the convection of heat will go on more rapidly, and what may be called the "effective conductivity" of the gas will be increased.

The complete elucidation of the part played by turbulence in the working of a gas engine seems to require more direct methods of investigation than the ordinary tests. During the past year Dugald

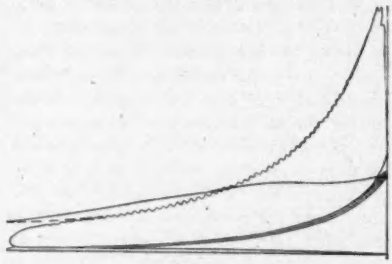


FIG. 1

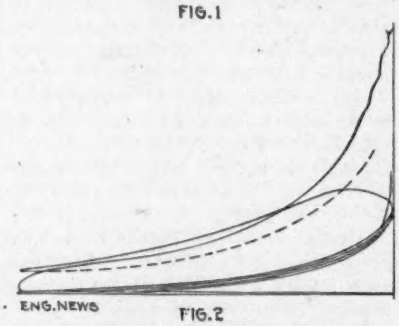


FIG. 2

Clerk has applied his method of indicating the engine with tripped valves, so as to obtain a "zig-zag" diagram, to the investigation of this point. During the first expansion line in such a diagram there is present the normal amount of turbulence which obtains in the ordinary working of the engine; during the second and later expansions of the "zig-zag" the turbulence has practically died out. We have here, obviously, a method of considerable delicacy for detecting and measuring the effect of turbulence in causing heat loss on the expansion line. Clerk has found that in the compression and expansion of air or carbon dioxide without firing, the engine being simply motored round, the rate of heat loss at a given temperature is greater in the first compression after drawing in the charge than in the subsequent compressions.

For the purpose of studying by this method the effect of turbulence on heat loss in the ordinary working stroke of a gas engine, Clerk tried the experiment of drawing in a combustible charge into the engine in the ordinary way and then tripping the valves and compressing and expanding this charge for one or two revolutions before firing. By this means the turbulence which, in the ordinary method of working, persists till the moment of firing was given time to die away. It was expected that a comparison of an expansion line obtained in this manner with that following a normal ignition would show the effect of turbulence on heat loss. While the experiment did not give any very clear indication on this point, it was the means of bringing to light a matter of perhaps greater importance. Clerk found that the result of damping down the turbulence was to retard the rate of inflammation of the gas to a very remarkable extent, so that the character of the diagram was completely altered. Two of Clerk's diagrams are reproduced (see Figs. 1 and 2), from an inspection of which the importance of this point in the working of gas engines will be appreciated. If ignition be delayed until the combustible mixture taken into the engine has been compressed and expanded twice and then again compressed, the period of inflammation is about two and a half times that of a normal ignition in which the gases have some turbulent motion. The diagrams shown, Figs. 1 and 2, were taken by an optical indicator from an engine of 9 in. diameter cylinder and 17 in. stroke, when running under full load at 180 revolutions per minute. The engine was fitted with two electric igniters, one operating at the charge inlet valve at the back of the combustion chamber and the other operating at the side of the cylinder close to the piston. In Fig. 1 the back electrical ignition was used, and in Fig. 2 the side igniter was in operation. It has been noticed more than once that the period of inflammation in the gas engine is considerably less than that obtaining in an explosion of a similar mixture in a closed vessel of the size of the combustion chamber, and it must have occurred to many that, were it not for this fact, it would hardly be possible to work internal-combustion engines at reasonably high speeds, because the ignition would be too slow. It now appears that this is wholly, or almost wholly, due to the fact that the gas in the engine is in turbulent motion.

Simultaneously with the experiments by Dugald Clerk described in the last paragraph, Professor Hopkinson—with the assistance of his pupils, Messrs. Miley and Peache—carried out some measurements of the effect of turbulence on heat loss and inflammation phenomena in a closed vessel explosion. A cylindrical vessel 1 ft. in diameter by 1 ft. long was used, and was lined with copper strip, the rate of heat loss being measured by a record of the rise of electrical resistance of this strip. A small fan was mounted in the center of the vessel and

*Proc. Inst. Mech. Eng., 1908, p. 5. See also Professor Callendar's remarks in discussion on paper by Dr Watson, Proc. Inst. Aut. Eng., Vol. iii, p. 457, where the limit of advantageous compression in the petrol motor is estimated as 4 to 5.

comparisons were made of the result of exploding the same mixture, first with the fan at rest, and second, when the fan was driven at a speed of several thousand revolutions per minute. These experiments also showed the great increase in speed of inflammation consequent on the motion of the gas.

Sewage Treatment vs. Sewage Purification*

By George C. Whipple†

The art of sewage purification has been making progress during recent years. Of this there is no doubt. The nature of the advance, however, has not been that which the popular mind believes it to have been. It has not been in the direction of making sewage more nearly resemble drinking water so much as it has been in adjusting the treatment to particular needs, making the treated sewage fit for discharge into some particular stream or lake, taking into account the subsequent use of this water. The greatest progress has not been in obtaining a higher degree of purity for sewage effluents, but rather in the invention of methods and devices applicable to conditions not previously encountered. To illustrate: the general results of that notable series of experiments made a quarter of a century ago by the Massachusetts State Board of Health, at Lawrence, was that the application of sewage to land according to the method known as intermittent sand filtration was the one best suited to the local conditions of that state. Time has proved that this conclusion was correct, and the plants that have been constructed have on the whole given satisfactory results. Intermittent sand filtration gives a relatively high degree of bacterial efficiency. But sandy soils of the proper character do not exist everywhere in the United States; they do not exist in England. Large areas are required and it is not often that these can be found at the proper elevation near large cities. Therefore, this excellent method of sewage purification is much limited in its application. The need of processes to fit other conditions led to the use of improved screens, of chemical precipitation works, of septic tanks, of sprinkling filters, of contact beds, processes excellent in their way, but as ordinarily operated not capable of purifying the sewage to the same extent as the older method of treatment on land.

Yet, and this is the point of my paper, these miscellaneous processes all go popularly under the name "Sewage-purification plants." In a certain sense this is correct, for they contribute to the removal of the objectionable ingredients and living organisms in the sewage. The sanitary engineer, knowing the nature of the results, makes a proper mental discount of the term and is not deceived. The layman, however, takes the word "purification" at its face value and is deceived. How many times do we hear city officials proudly boast that the sewage of their city is in no way dangerous because it is purified in a septic tank, when it would seem that the use of one's nose and the application of a little common sense would lead to a different conclusion.

There is no more fatal error in logic than failure to properly define the premises; nothing contributes so much to controversy and misunderstanding as the use of terms of uncertain meaning. The speaker believes that much of the prevailing discussion with respect to the advisability of adopting this or that method of guarding water-supplies against infection and of preserving the quality of the water in our waterways has been confused in the minds of many on account of the use of the term "sewage purification" to cover methods and processes that do not make the sewage pure.

It is gratifying to observe that there is an increasing tendency among sanitary engineers to substitute for the term "sewage purification" the words "sewage treatment." Notably, George W. Fuller has adopted this language in his recent admirable treatise on sewage disposal. It is to be hoped that its use will become general. If not, the term "sewage purification" will inevitably become degraded, as people come to learn, as they must, that not all so called purification plants really purify the sewage. The term "sewage treatment" does not imply complete purification and is, therefore, the more general and the better term.

Using the words in their most obvious meaning, let us ask the question, ought the sewage of our American cities to be purified? Generally speaking, no. To do so would be enormously expensive, and in most cases the results accomplished would not be commensurate with the cost. Ought the sewage of our American cities to be treated in some way before being discharged? Generally speaking, yes. There are relatively few instances where raw sewage can be discharged into streams or lakes without causing objectionable local conditions or dangers of a sanitary character. The nature of the treatment required will vary all the way from a mere straining out of the grosser solids to a combination of processes that results in actual purification.

We hear it said that in England practically all of the sewage is purified. Is this true? Yes, if it is meant that the sewage is submitted to some process that improves its character, but no, if it is meant that these processes completely remove the organic matter and free the sewage of its dangerous bacteria. For example, we like to refer to the interesting sewage works at Manchester and Salford with their great septic tanks and contact beds and sprinkling filters, and we speak of them as purification plants. Do we realize, however, that analyses of the sewage effluents show that during a large part of the time they fall below the standard of purity established by the Mersey and Irwell Joint Committee, a standard that cannot be regarded as too strict if we maintain a reasonable meaning of the word "pure." The biennial report of Hugh Stowell, Chief Inspector for the Mersey and Irwell district, dated May, 1912, states that out of 126 sewage works, 23% were non-efficient, this being an improvement over 34% as shown by his previous report. At Manchester 22% of the samples were below the established limit for organic matter of "one grain of oxygen absorbed per Imperial gallon in four hours," at Salford 12.8% of the samples were below standard. This is not intended as a criticism of English methods of treatment, which, on the whole, are well adapted to their particular needs, but merely to illustrate the danger of using loose phraseology.

Or to take another illustration, can the water-supplies of our lakes be protected by purifying the sewage that enters them? Many laymen think so, and ardently advocate the construction of sewage-purification plants and oppose water filtration. Would they say the same if they realized that most so called sewage-purification plants only partially remove the dangerous substances from the sewage, and that complete removal is impracticable on account of the expense and the almost insuperable difficulty of treating all of the sewage at times of storm. Would not these well-meaning people have a clearer conception of the problem if instead of using the broad misleading word "purification," we used the term "sewage treatment," or still better, some term that described definitely the results accomplished by the different processes.

With laws being framed in various states to control the pollution of rivers and waterways, it is high time that popular misconceptions should be corrected and that the different phases of this complicated problem should be made clear. In the first place it should be more definitely understood that in the treatment of sewage there are two very different functions to be considered. One is to get rid of the foul, putrescible matter with its accompanying offensive smell; the other is to get rid of living disease-producing organisms. One is very largely a physical and biochemical problem; the other is chiefly bacteriological. One does not directly concern the public health; the other may. In practice, these functions overlap but they may be kept separate.

*A paper read before the general session of the American Public Health Association, Washington, D. C., September, 1912.

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Is it not the popular conception of the function of sewage-disposal plants that they are intended primarily to protect the public health? Is not this the theory upon which some of the recent legislation is based? It certainly appears so. But is this idea correct? Does the treatment of sewage by the ordinary process materially improve the public health? Are sewage works a success from the hygienic point of view? It is a vital question and one that has not been sufficiently considered from the standpoint of cost and result.

Sanitary history has shown that when polluted water-supplies have been purified by filtration, the typhoid fever death rate of the community has lessened and the public health has otherwise materially improved. And it is a matter of easy reckoning to tell that the financial benefits represented by the saving of human lives and the prevention of sickness have far exceeded the cost of filtration. Taking the cost of efficient water purification at $10 per 1,000,000 gal., and allowing a per capita water consumption of 100 gal. per day, the process pays for itself if it reduces the typhoid fever death rate by 4 per 100,000.

No such record can be shown for the purification of sewage except perhaps in the case of a few small plants built for the protection of the water-supply of some large city, and even here it is difficult to measure the number of lives that have been saved. The complete diversion of sewage from the drainage area of a public water-supply has repeatedly been of hygienic benefit. So has the introduction of sewer systems in cities and towns where none existed before. But the purification plants that have been constructed for the large cities of the world have not the saving of many human lives to their credit, so far as the best available evidence shows. The reason is obvious. They have not, as a rule, been built for that purpose, popular ideas to the contrary notwithstanding.

Sanitarians abroad have long recognized the fact that river water-supplies cannot be protected against the danger of infection by any of the known methods of purifying sewage discharged into the river above the water-works intake. Instead they depend upon the filtration of the water-supplies themselves. In Germany the filtration of surface water-supplies is required by law and no difficulty has been found in building water-filtration plants capable of purifying water after it has received what would be regarded in this country as a large amount of sewage. In Germany and in England sewage-disposal works are built primarily to remove organic matter and prevent streams from becoming foul. Therefore, when public-health authorities in this country compel large cities to construct sewage-purification plants for the avowed purpose of protecting water-supplies taken from the rivers below them, they are attempting to accomplish the impracticable, and are compelling the expenditure of money without adequate returns. The most that can be expected in this direction is to lessen the burden placed upon the water filters and in some instances this may be desirable.

The pollution of water-supplies is not the only thing involved in this matter. Sometimes it is a question of protecting shellfish supplies, or of bettering the sanitary condition of the water at bathing beaches. These may be fairly classed among the direct sanitary benefits of sewage treatment, but here the treatment to be of benefit must be quite complete and, therefore, expensive, while the number of lives saved is probably small.

It would not be right to balance the cost of sewage purification against the saving of human lives, were it not for the fact that our cities are subject to debt limits and that money is needed for many other purposes that affect the public health; for cleaner streets, for better care of schoolhouses, for parks and playgrounds, and for the special needs of the department of health in securing safer milk and food supplies, and for all sorts of hygienic and sanitary inspections. In view of the steadily increasing tax rates in our large cities it behooves sanitarians to find out for each city in which direction money allotted to the saving of human lives will do the most good. In other words, how can the most lives be saved for a dollar? Whatever the answer may be, it is not likely to be found in the purification of sewage.

That the sewage of most American cities should be subjected to some form of treatment is conceded. The need will increase as our cities increase in size and number. The problem at hand is to determine the most appropriate treatment for each case, bearing in mind the results that can be accomplished, the peculiar local condition, the cost of construction, maintenance, depreciation and operation.

Processes of treatment perform one or more of three functions: clarification of the sewage, oxidation of the organic matter and removal of bacteria. The effect of the methods of treatment now available and in common use are given by Fuller in his treatise already referred to as follows:

Method	Percentage purification		
	Suspended matter	Organic matter	Bacteria
Fine screens (30 mesh or finer)	15	10	15
Sedimentation	65	30	65
Septic treatment	65	30	65
Chemical precipitation	85	50	85
Contact filters*	85–90	65–70	80–85
Sprinkling filters*	85–90	65–70	90–95
Intermittent sand filters*	95–99	90–98	98–99

*The figures for the last three forms of treatment are on the assumption that the sewage is given some form of preparatory treatment before it is applied to the filters, and that with the sprinkling filters the effluent is allowed to settle.

It is evident that some of the processes that are used primarily to prevent sewage from producing foul conditions do also remove many bacteria and to the extent that they do this they improve the sanitary quality of the treated sewage. Often this can be accomplished at low cost, while to effect a reasonably complete and useful bacterial removal would very greatly add to the expense. This treatment of sewage to a less degree than that of complete sanitary purification may pay, even though the direct hygienic aspects of the case be ignored, for whatever eliminates public nuisances adds to the comfort of the public, and tends to restore depreciated real estate values.

The above ideas are not new to sanitary engineers; they know the limitations of the various methods of treatment; they know how well they work when kept in order, and how grievously they fail when not properly operated and enlarged as need requires; they are able to determine what methods or combination of methods are best suited to any case. Yet in common parlance and in official reports they continue to say "sewage purification" when they mean something less. Perhaps a better term than "sewage treatment" can be found, but let us at least be more particular in the use of terms describing the processes discussed, lest the cause of sanitation suffer a reaction from the over-zealous interest of laymen based on false conceptions.

Linseed Oil and Turpentine have been studied by the Bureau of Standards to determine their specific gravities and coefficients of expansion. Sixteen samples of linseed oil (one Argentine, the others American), and 12 samples of turpentine (six of gum turpentine, six of turpentine obtained by wood distillation) were studied.

The specific gravities of the linseed oils at 25° C. were found to range from 0.92499 to 0.92756, averaging 0.92634. The coefficient of expansion was found to be variable, and the results are, therefore, expressed by a formula giving the density at any temperature in terms of the density at 25°:

$$Dt = 0.92634 - 0.0006847\ (t - 25) + 0.000,00012\ (t - 25)^2.$$

The specific gravities of the gum turpentine at 25° C ranged from 0.85719 to 0.86240, averaging 0.85984. The coefficient of expansion is variable, the formula derived for the density being:

$$Dt = 0.85984 - 0.000817\ (t - 25) - 0.000000094\ (t - 25)^2.$$

The turpentine obtained by destructive distillation gave closely similar results, except one sample, sold as "oil of turpentine," had a much higher density, 0.9433 at 25° C.

The above specific gravities are referred to water at 4° C.

Technologic Paper No. 9 of the Bureau of Standards, by H. W. Bearce, which gives these results, contains tables giving the densities of linseed oil and turpentine at various temperatures, for various 20° densities. It also gives extensive multiplication tables, gallons to pounds, and pounds to gallons, for linseed oils of various densities from 0.919 to 0.935, and for turpentines of various densities from 0.847 to 0.874.

A British Novelty in Centrifugal Pumps

A centrifugal pump of interesting design, known as the Rees "Returbo," has recently been brought out in England and is being made in this country by the Manistee Iron Works, of Manistee, Mich. Interest centers in the impeller, which is intended to develop pressure head directly by centrifugal force without intermediate velocity action as in the ordinary type.

Fig. 1 shows two sections of the simplest form of impeller. The cross-sectional area of the water passages is large compared with that of the discharge openings, so that the interior of the impeller forms a "pressure chamber" in which the water is constrained to revolve. The velocity of flow through this chamber is comparatively low and it is claimed that frictional losses are correspondingly reduced.

With an impeller of this design, it is claimed that the flow increases inversely at the head, and *vice versa*, in such a manner that the power input is approximately constant for constant speed with wide variations of head. The makers cite

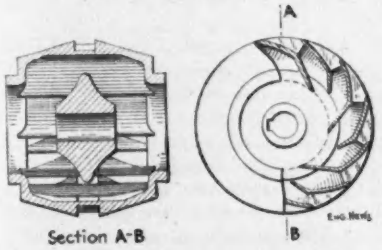


FIG. 1. SECTIONS OF THE REES "ROTURBO" PUMP IMPELLER

the case of a 150-ft. head, 925-r.p.m. type delivering 158,400 gal. per hr. through a 12-in. pipe; results of shop tests are given in Fig. 2. At zero flow the discharge valve was closed.

Thick and Thin Water—An interesting note which should have value to hydraulicians and others appears in a recent newspaper report, which we quote as follows:

THICK WATER SAVES LABOR
Government Boats Do Not Need Calking in the Missouri.

The removal of the revetment equipment back to the Missouri River has brought joy to the hearts of the crew. The unwelcome task of frequent calking will be avoided for a while. When the barges, quarter boats, steamers, etc., were sent up the Big Sioux River last fall to winter quarters every hull in the lot immediately began to leak. The thin water of the Big Sioux River was the cause.

During the winter and spring the equipment had to be inspected frequently, and repairs were made to prevent serious trouble. One pile driver was more susceptible to the thin water than the other hulls and sank.

The authorities in charge of leaky dams and canals might find it of advantage to import some of this thick water for doing some local calking and avoiding breaks.

Theory and Practice of the Painting of the Modern Steel Passenger Car*

BY J. W. LAWRIE†

Since the very general introduction of the steel passenger car into our railway service, new problems in painting and preserving the steel have been brought to our attention. It is true that the problem of the preservation of steel is not in itself new to us, but the artistic protection of steel from corrosion, etc., is a new problem. A railway passenger coach must be painted not only carefully, but also so as to present a pleasing appearance to the eyes of the traveling public. This effect is arrived at by the color, luster, harmony of colors, etc.; thus some of the pigments which have great value for steel protection cannot be used, and others that do not have merit for steel protection must be used merely on account of the colors they possess. The railways in general have retained the same standard colors for steel cars that they had for wood cars. The consideration of the protection of steel has been secondary to the color of the finished coach. Fortunately, this consideration has not been felt for certain colors, because we have found good inhibiting pigments which harmonize with the color desired and afford good protection to the steel.

Paints for steel have different functions, in many respects, than those for wood. In painting steel we have the absorption into the pores to only an extremely limited extent, compared to that which we have in painting wood. For this reason there must be some other way adopted for getting the strong clinging effect that the pores of wood afford as an anchorage for the paint coats. Once we have the priming coat well anchored, the subsequent coats, if properly made and well applied, anchor themselves one on the other, all finally depending for their adherence on the fastness of the priming coat and the strength and elasticity of the paint film. With steel we have only to a very limited extent inter-crystalular crevices, most minute in size and depth. These do not afford a firm anchorage, nor is the penetration of the paint into these crevices of much value for anchorage. Sandblasting steel gives a slightly roughened surface, which aids materially in holding the paint to the steel. It is almost necessary to assist an oil paint with something which is a better adherer to steel than linseed oil. This we find in varnishes. For this reason we find in all steel primers a certain amount of varnish. At the same time the pigments which have answered for wood may or may not do for steel. Depending on the color, we may have more or less pigment to get proper opacity; for dark colors less, and for light colors usually more, pigment is necessary than in the paints used for wood. It has been established in a practical way, as well as experimentally, that the fewer the number of paint coats on steel which will give the maximum protection the longer and the better service will the paint coating give. Corrosion itself may be due to several factors. Moisture must be present for continuous corrosion; acid gases and oxygen assist, and any free acid, such as is used in pickling steel, is a strong inducer of corrosion. When we consider these causes, then we can attempt to get ways of overcoming the effects of such actions and so approach perfect inhibition of corrosion. It must be borne in mind, however, that inhibition of corrosion is only one of the desirable qualities of a paint for steel.

In general, we can functionate the properties of both the pigment and the vehicle for painting steel.

The pigment must give us color and desired shade, opacity, thickness of film; it affects the life of the paint, both by its actinic action due to its color absorption, etc., and its chemical effect on the oils or vehicle. It should be such as to give the maximum inhibition of corrosion on the steel.

The vehicle has for its fundamental functions the binding of the particles of pigment together, and the cementing of this bonded material on to the steel surface. It gives life to the paint and gives the finish effect desired as to lustre, etc. It must also be such as to exclude from the steel surface all moisture and gases.

Both pigment and vehicle have additional functions other than those given. These mentioned are the ones of greatest consideration in the study of proper paints for steel protection.

There are essentially two, or perhaps three, great classes of pigments as regards their effect on steel. These classes can be called the "electrical," the "chemical" and the "passivifiers." Examples of the passivifiers are the chromates, which seem to render the steel immune to oxidation.

In line with the electrolytic theory of the corrosion of steel, any differences in electrical potential produce currents of electricity in the direction of the high to low, or from positive to negative. The different pigments show many differences in their potential relations to steel. For this reason, if we use pigments which are positive to steel, then in any resultant flow of current we would have the positive material going into solution and the negative material, in this instance the steel, protected. Such pigments would, therefore, be inhibitors of corrosion of steel. Those of the same potential, or neither positive or negative to steel,

*A paper presented before the Eighth International Congress of Applied Chemistry, New York City, Sept. 9-12, 1912.

†Pullman, Illinois.

would be neutrals and those of negative potential would be accelerators.

The chemical pigments are those which through their particular chemical properties, such as acidity (either directly or through hydrolysis), neutrality, or alkalinity, affect the steel so as to accelerate or inhibit corrosion. It is practically established that there is a minimum alkalinity below which there is no inhibition, and also that with too strong alkalinity the action of the pigment on the vehicle oils is so pronounced that such pigments are detrimental to the life of the paint.

Practically all pigments belong to both electrical and chemical classes. A pigment may be positive to steel, and yet in itself or by hydrolysis be so acid in action that instead of being, as we would expect, an inhibitor, it is instead, a stronger accelerator of corrosion. In the same manner, a negative pigment may be sufficiently alkaline as to become an inhibitor. Many pigments are both positive and alkaline, and, therefore, extremely good inhibitors. Others are neutral, either through opposing electrical and chemical properties (as applied to inhibition, etc.), or are neutral of themselves in all respects. Again, other pigments are negative and acid, and so strong accelerators. There are ,of course, all grades and stages in these valuations. It is, however, possible by test to identify the different properties of the different pigments and combinations of pigments, and so classify them as to their actual value for inhibiting corrosion.

The knowledge of these classes is worth having, but not of great importance, unless we have satisfactory methods of determining to which class each and every kind of pigment or mixture of pigment belongs. It is possible to measure directly differences in potential between pigments and steel, and also the relative acidity or alkalinity, either as a direct property or as one produced by hydrolysis. These tests can be applied directly to most pigments, but not to all.

There is one test which can be considered final and fair. That is, an actual exposure test of the pigments combined into paints and applied to steel panels under differing exposure and weather conditions. It must be admitted at once that such tests are not absolute, but their relative value cannot be disputed. It is impossible from the results of such tests as those at Atlantic City* to say that the American vermilion is 10 times as good a pigment as some other pigment which would be rated at 1. The relative fact is that American vermilion is a first-class inhibitor of corrosion, whereas the paint rated at 1 is not an inhibitor, and is probably one of the negative pigment paints, and, therefore, an accelerator. It is extremely tedious, however, to wait four or five years for such an exposure test to give reliable results. Events and truths in paint-grinding history are moving much too fast; some other means must be had for testing out pigments and vehicles in a shorter time and yet with a reasonable amount of assurance that the results so obtained will be checked up by the actual exposure or railway-service wear.

I have been experimenting for a long time with the so called "razor-blade" test for both pigment and vehicle. The test is made by completely separating the pigment from the vehicle by solvents and the centrifuge, so that there is no trace of the vehicle left with the pigment. The pigment is then reground until all of it passes through a 100-mesh sieve. It is then made into a stiff paste with water, spread out on a square of filter paper and the emeried razor blade is wrapped up in the pigment in such a manner that the pigment is in intimate contact with the surface of the blade all over. Here is where many fall down on the test. The wrapping up of the blade properly has much to do with the success of the experiment. The blades are now left for about 21 days, being kept moist all the time. They are then cleaned, reweighed, and the loss in weight, together with the appearance of the blade, give the value of the pigment for steel protection. I have followed the results so obtained with outdoor exposure panels, and have seen the conclusions arrived at from the razor-blade test check with wonderful accuracy the results obtained on exposure. As examples of these checks I give the relative values placed on some of the Atlantic City steel panels and the losses on the razor blades:

	Loss Razor Blade	Atlantic City rating
American Vermilion	0.0005	10
Sublimed White Lead	0.0015	9
Corroded White Lead	0.0247	2½
Red Lead	0.0003	9
Zinc Chromate	0.0004	9

I have made these tests on over 200 different pigments and mixtures of pigments, with the exposure test for a check. The results indicate that when properly carried out the blade test is reliable and of great value where time is such an important factor as in large testing laboratories.

In like manner the vehicle can be tested for its value as a resister of moisture and gases. The emeried and weighed razor blade is dipped into the separated vehicle and given two coats, with proper drying intervals. The blade is now subjected to alternating treatments with water and moist SO_2, and CO_2 gases. This treatment is continued for a period of 11 days. The blades are then cleaned and reweighed. The appearance and loss in weight give the relative value of the vehicle as a resister of moisture and gases.

Here we also use the filmometer with great success. This particularly where we are called upon to test paints from competing companies, and designed for the same purpose. The test of the resistance of the film to acid and gas penetration is of extreme importance. We have in railway service to contend with SO_2 and CO_2 gases, as well as an almost continuous presence of moisture. For this reason, the paint must be able to exclude these gases and moisture. This exclusion depends largely on the nature of the vehicle. Straight linseed oil or soya-bean or other like oils will not exclude completely. If, however, we add a gum varnish to the oil, the porosity is largely stopped. This, of course, is more or less perfect, according to the amount of varnish used, its kind, etc. At the same time the physical condition of the pigment must be considered, as too coarse a pigment will practically always leave a porous film. Too much varnish, on the other hand, especially in a priming coat, will leave a glossy surface, to which the second coat will not adhere well. At the same time it is well established that varnish will not carry a large amount of pigment and give successful outdoor surface. It is for this reason that there have been so many failures with the so called "quick process methods" of finishing steel cars.

We have made many tests to establish the value of baking the paint on steel cars. Our results, and practical experience, based on these tests, have shown that the life of the baked paint on steel is prolonged wonderfully, and also the adherence to the steel itself is very much better. At the same time the baking has the additional value of making the vehicle much more impervious to moisture and gases than the same vehicle unbaked. Numerous experiments with certain kinds of vehicles baked gave a resistance in this way of almost three times that of the same vehicle unbaked. The mechanical difficulties of baking an entire car are large. We are at the present time experimenting in this direction. In this respect, the removable sheathing of the modern Pullman is of a decided advantage, as it can be readily taken off, the paint removed, the sheathing repainted, baked and placed back again on the car as before.

There are some other difficult problems involved in the baking of the paint. For example, it is the best practice at the present time to bake the surfacer. This baking produces an extremely hard and brittle coat. Up to the present, when it is necessary to refinish such a car, we have not found any chemicals which will successfully remove this baked surfacer. It is, however, possible to remove all coating over the surfacer and then rebuild up again in the regular manner. Here, again, the problem of baking the entire car is paramount, and so far we have not solved the problem with entire success.

*See Engineering News, Sept. 10, 1908, and July 27, 1911.—Ed.

The baking temperature and length of time baked have a great deal to do with the life service of the paint. There is, for most vehicles, a minimum heat necessary to produce the internal changes in the vehicle, which give it the valuable properties so desired. This change has also a time factor. In general, the lower the temperature and the longer the time the paint is baked, the better the wear, service and resistance to moisture, and the more elastic the film. Twelve hours at 180° F. are better than five hours at 280°.

There is no longer any argument with regard to the preparation of the steel for painting. Wherever possible sandblast. Pickle only when no other means affords itself to remove scale and rust. Pickling with sulphuric acid gives, under our usual factory methods, the best accelerator of corrosion of any agent met with in regular railway service. Capillary attraction is an extremely powerful force and the sulphuric acid, by this force, enters the spaces between the crystals of the steel and is held there very tenaciously. A mere dipping in a bath of water or several baths of water fails to remove all the acid and with the hydroscopic nature of sulphuric acid an ever increasing area of steel is subjected to acid action. The whole sheet begins to corrode under the paint coat. Even with a paint which is inhibitive and moisture proof, such action of the acid will soon destroy these valuable properties. The action of the acid is cyclic and almost unending. Ferrous sulphate is readily converted to ferric sulphate and, with moisture, to ferric hydrate. Under these conditions the ferric hydrate is precipitated out of solution and does not react further with the acid, but the acid is regenerated and again reacts with the steel, etc. The ferric oxide formed is electro negative to steel and with moisture and acid a current is established, carrying iron into solution. This is preciptated out as more ferric hydrate or oxide, and so again the action proceeds—*ad infinitum*.

I would rather pickle with hydrochloric acid than with sulphuric acid even at a higher cost, because this acid is not hydroscopic; it is volatile at a low temperature and its capillary force is small compared to that of sulphuric acid. It can, therefore, be washed out with greater ease and sureness and can ultimately do less harm if not entirely obliterated. If you have to pickle with sulphuric acid, then wash with a stream of hot running water, so as to overcome by heat, force and dilution the capillary strength of the acid. Treat with lime water and wash again, dry and oil.

There is one feature of steel-car building that is generally neglected. The outside surface of the steel is taken care of in a more or less respectful manner, but the inside of the sheet is usually given a coat of slush paint and the scale is seldom removed. Oil may be on the surface, or rust already formed. This treatment is certainly to be condemned. The inside of the outside and the outside of the inside sheets form a box with little ventilation, but usually holding a great deal of moisture. The paints used are seldom good resisters of moisture, and as a result corrosion starts and is aided by the conditions until there is often danger that the inside of the sheet will corrode through before the paint on the outside has seen decent service. As color is of no interest in this case, it is easily possible to apply a good inhibiting and moisture-resisting paint on these unseen sides of the sheets of steel and so prolong the life of the car very much. It is also a matter of general safety properly to paint this material, as it is impossible to get at the surface for repainting after the car is in service.

Where molding abuts on steel sheets it is usual to interpose sheet copper between the two pieces of steel. This is to produce as near a water-tight joint as possible, but the fact remains that the joint is never entirely water tight. Copper is electro-negative to steel, and the steel, therefore, goes into solution and rapid destruction takes place. I have seen siding renewed on many cars in less than nine months, and the destruction could be traced directly to this electrolytic effect. Aluminum, on the other hand, is electro-positive to the steel, and so it goes into solution and saves the steel. It soon coats over with oxide and thus the reaction is largely diminished. The steel itself is entirely protected. This substitution of aluminum for copper was made entirely as a result of the electrolytic theory and the test of its worth by means of the well known ferroxyl-agar-agar test of Cushman, Gardner and Walker. The copper in contact with the steel in the agar jelly caused the flow of current and the liberation of iron ions, which, with the ferri-cyanide, gave the characteristic blue-green color. With the aluminum under the same conditions there was formed the pink, due to hydroxyl ions and the white aluminum ferri-cyanide.

The usual procedure in finishing a steel car is, first to sandblast, next to prime and to follow usually with a second but different primer, then to use a filler and surfacer, and finally to apply the color and varnishes. There are several essential properties which should be possessed by the different kinds of paint used on steel.

The essentials of a good first primer or first coat of paint on steel are that it adhere well, present a good surface for the second coat, and that it have a pigment that is a good inhibitor of corrosion. It is not essential that the vehicle be altogether gas- and moisture-proof, although it is better so. The second coat should adhere well to the first one. It should be primarily a paint that is a good excluder of gases and moisture. It does not have to have a strongly inhibiting pigment, but it is better with such a pigment. It is usual after the application of the fillers and surfacers to rub down to a smooth finish with water and pumice. This treatment requires undercoats which will resist wear and, next to the steel, a pigment that will prevent corrosion, even if some moisture gets through the outer coats. It has been possible to get better results from two coats instead of a single primer combining all qualifications. It is more practical also to get the resistance to moisture by making both coats moisture proof than by depending on the second coat alone.

The fillers or surfacers are designed to give a film that can be rubbed down to a smooth surface without tear and still be flexible. Most of them are fairly brittle and all of them are hard. The brittleness is increased with the baking. It is, however, possible to make a surfacer which will be hard enough to rub well and still be very elastic. Such an elastic surfacer will give to the paint coats, as a whole, much better wear and freedom from checking than a more brittle and nonelastic surfacer. The coats of color, etc., following the fillers are never or seldom baked. It is very difficult to hold the shades and finish constant when we bake the finishing color coats and varnishes.

I have tried to show the theory of steel-car painting as it has been applied with some success in a practical manner on a large scale. We are using every day the tests and theories described with increasing confidence in their practical value. There are still many new phases of the work to be thought out and problems to be solved. We need more men with a little time for the practical theoretical work of the proper protection of the steel passenger car.

The Railways of New South Wales added about 74 miles of new line to the system during the past year, making a total of 3832 miles in use at the end of June, 1912. About 600 miles were under construction and 220 miles authorized at the end of the year. The 313 miles of double track are operated on the absolute block system (except three miles on the permissive system), while the 3516 miles of single track are operated by electric tablet, electric train staff, or train staff and ticket.

There is an increasing difficulty in obtaining ties, which has delayed the opening of some new lines, and the Railway Commissioner, in his annual report, recommends prohibiting the cutting of ties for export. The colony has 196 miles of electric railway, but their operation is costly, absorbing 84.2% of the receipts, while the operating expenses of the railways absorb 64.2% of their receipts. The report makes no mention of the recent movement for a uniform gage for the railways of the several colonies now united in the Australian federation.

Repairing the Break in the Irondequoit Embankment on the Erie Canal

We described in our issue of Sept. 19 the recent break near Rochester, N. Y., in the line of the new New York Barge Canal where it is carried across Irondequoit Creek on a high embankment. As this forms a part of the present Erie Canal channel, all traffic on the canal is tied up until this break can be closed. This is a season when traffic on the canal is heaviest and a large number of boats are lying at either end of the break waiting for it to be closed. As these boats, however, have a maximum draft of less than 7 ft. and a width of less than 18 ft., the task of carrying a channel across the break is far easier than would be the case if the completed barge canal were in use by the 2000-ton barges it is intended to accommodate.

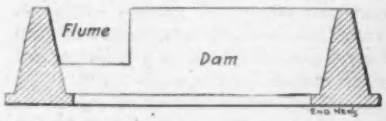


FIG. 1. SKETCH SHOWING CONCRETE DAM ACROSS CONCRETE-LINED CHANNEL LEAVING SPACE FOR TEMPORARY WOODEN FLUME AT END

FIG. 3. VIEW OF NEW EMBANKMENT TO SUPPORT TEMPORARY WOODEN FLUME UNDER CONSTRUCTION. CONCRETE DAM AND TIMBER FLUME INSIDE CONCRETE-LINED CHANNEL SEEN IN BACKGROUND

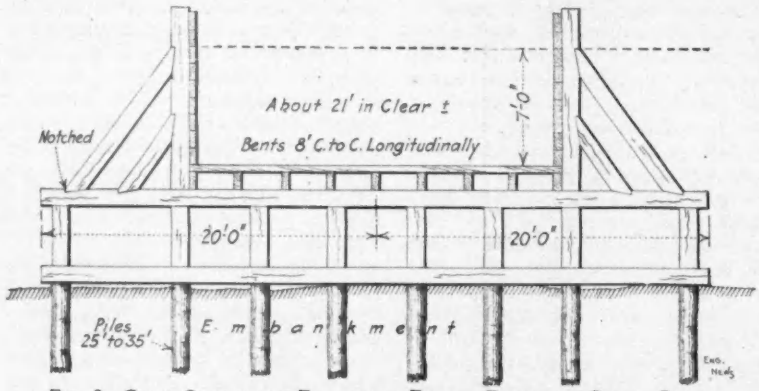


FIG. 2. CROSS-SECTION OF TEMPORARY TIMBER FLUME TO CARRY CANAL ACROSS THE BREAK SUPPORTED ON PILES

Immediately after the break occurred on Sept. 3, work began toward its closure. The first work started was the refilling of the washed-out embankment across the break. The portion on the north side rising higher than the level of the canal bottom was leveled off to widen the embankment. Dirt was brought in by dump cars and locomotives and in this way a fill was carried across the break with its top at about the level of the bottom of the concrete trough. At the same time two concrete dams, or bulkheads, were built across the concrete trough at each end of the break, leaving at one end an opening the width of the temporary channel to be provided. These dams rest upon the lower course of concrete of the trough and are 10 ft. 6 in. thick at the base and 2 ft. thick at the top. The height of the dam is 17 ft. 6 in. The accompanying sketch (Fig. 1) shows the position of the dam between the retaining walls and the concrete trough, and also the opening left through it for the timber flume which is to extend between the two dams, which are about 900 ft. apart.

Each of these dams is located about 200 ft. back of the break and for this distance the wooden flume is carried on the bottom of the concrete trough. The remaining 500 ft. is carried on piles 25 to 35 ft. in length, driven in the earth fill which has been made across the

FIG. 4. BUILDING WOODEN FLUMES INSIDE CONCRETE CHANNEL

break. These piles are driven in bents 8 ft. apart with eight piles to each bent and are capped with 12x12-in. timbers 40 ft. long extending transversely. Upon these pile caps are placed short posts 3 ft. 6 in. high, one over each pile. A second 12x12-in. cross-timber is placed on top of these posts. Upon this cross-timber the wooden flume is built. The floor of this flume is made up of eight 6x12-in. stringers spaced about 33 in. apart on which 3-in. planks are laid crosswise. The side walls of the flume are supported by 12x12-in. posts with two 12x12-in. braces dapped into the cross-timber as shown in the sketch. The lining against these posts is of 6x12-in. timbers. The timbers and linings are drift-bolted and spiked wherever necessary. The flume is about 21 ft. in width inside.

The latest information received from the break was to the effect that the flume would be completed and ready for the passage of canal boats about Oct. 10, which would be 37 days after the break.

Our readers who followed carefully the description of the break in our issue of Sept. 19 will be interested to examine the accompanying photographs of the culvert under the embankment. Heavy rains and high water with the obstruction of the channel of the creek below the break by the washed-in débris have prevented any careful examination of the foundations of the culvert. The accompanying photograph shows well the composite character of the construction, the original stone arch of 1821 being on the exterior, the second interior stone arch being put in to strengthen it in 1856, and finally the thin reinforced-concrete lining put in place in connection with the recent reconstruction.

The condition of this failing culvert as shown in the picture suggests strongly that the foundations of the structure have been gradually giving way for a long time. It seems reasonable to believe that the timber mud-sills, on which the culvert walls were laid when the structure was originally built in 1821, may have been gradually crushing and perhaps decaying through fall in the ground-water level during dry seasons. Some of our readers may recall our description in 1907 of a bad break on the Erie Canal which occurred five years ago in the City of Syracuse, where a culvert gave way through the failure of the mud-sills under its foundation walls.

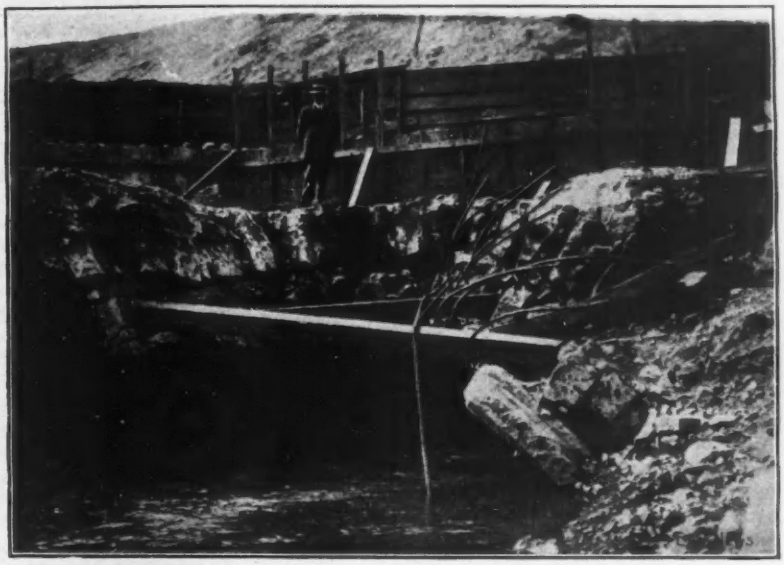


FIG. 5. LOWER END OF BREAK IN IRONDEQUOIT CREEK CULVERT SHOWING THREE SUCCESSIVE ARCH RINGS

FIG. 6. REAR VIEW OF CULVERT ARCH SHOWING FRACTURED STONES AND CAVITY BETWEEN ORIGINAL ARCH AND SECOND ARCH

It would be interesting to know how many million dollars have been spent in repairs on the Erie Canal which were made necessary by the use of timber as a foundation for masonry in the original construction. Some of our older readers may recall that when the so called $9,000,000 enlargement of 1895 was undertaken, which involved a slight deepening of the bed of the old canal, it was found that the slope walls on the canal banks for a large part of the distance rested against a timber sill in the canal bottom. The deepening of the channel removed the support from this timber sill and allowed it to slide inward under the pressure of the slope wall. Mr. Barrally's article, in our issue of Sept. 19, also pointed out how numerous have been the failures of structures on the old canal which could be traced to the use of wooden foundations under culverts.

It will not do, however, to unduly blame the original builders of the Erie Canal for their liberal use of wood under such conditions, for what they did represented the best engineering practice of that day. Indeed, up to very recent times the extensive use of timber in foundations below the water line has been the almost universal custom. Two things are bringing about a change in this feature of engineering practice: one is the increasing cost of sound timber of first-class quality, and the other is the increasing confidence in well laid concrete even when it is laid under water.

However opinions may differ as to the immediate cause of the accident at Irondequoit Creek, it is safe to say that before a permanent embankment is built across the break, the old culvert will be entirely rebuilt on secure foundation.

State Regulation of Public Utilities*

By Morris Knowles†

The basis of state regulation of industry is the fundamental common-law principle limiting the institution of private property itself. No man may use his property in a way opposed to the good of the community in which he lives, and which protects him in his possession of such property. A second principle, also inherited from the earliest days, is that he who devotes his private property to a public use thereby clothes it with public interest, which justifies not only great rights, but also public regulation.

In various periods of history many different occupations have been considered subject to this principle. In mediæval days the baker, the miller, the innkeeper, the barber, the tailor, the victualer, and the smith were required to supply all patrons on equal and customary terms. When physicians and surgeons were rare, they had to serve reasonably whoever called upon them. Later, with the development of towns, the ferryman, the wharfinger, and the carrier were held subject to public regulation. In the early days of the Massachusetts Colony monopolies were granted to the trade guilds by the General Court and held to be public callings. Still later, the widest application has been given to the term at various times. Common carriers, water, gas and electric companies, power companies, telephone and telegraph companies, warehouses and grain elevators, bridges, canals, ferries, waterways, draymen and hackmen, and many other lines of business have been held to be public callings. If we should go to the decisions of the courts with regard to what are public purposes, properly subject to government ownership, we find that libraries, theaters, hospitals, ferries, cemeteries, skating rinks, musical entertainments, exhibitions of fireworks, employment offices, etc., have been included.

Even in the most individualistic times public utilities have been considered subject to public regulation and required to perform any duties laid upon them by statute. In addition they have been held to certain common-law duties with regard to service and non-discrimination; and their rates have been regulated on the ground that they have no right to take a return on the unearned increment of their franchise value by charging what the traffic will bear. These duties have been briefly defined as follows:

(1) To perform all duties required by statute.

(2) (a) To serve all who apply.

(b) To provide safe and adequate service.

(c) To charge just and reasonable rates.

(d) To make no discriminations either in rates or in service.

It should be noted that these duties are all affirmative, differing in this respect from the negative obligation not to injure others by the use of property for private ends.

This is not the place to discuss the relative merits of municipal ownership and public regulation. Indeed, such a discussion would be entirely irrevelant to our subject, for, whether utilities are publicly or privately owned or operated, the need of broad regulation by the state or sovereign power is the same, and the methods and principles are identical. The duties of public utilities in the two cases are precisely similar. If the principles developed by countless decisions of courts and commissions are sound and just; if every applicant has the right to be served; if property should be so used in such services as to provide safe and adequate service; if discriminations are unjust and contrary to public policy; if depreciation ought to be allowed for; if it is unjust for taxpayers to contribute to lighten the burden of consumers, or for consumers to pay in rates any portion of general government expense, which ought in justice to fall on taxpayers—then the regulation of public services is just as much the right and duty of the state in the one case as in the other. In its governmental functions the municipality is but the agent of the state; in its purely business enterprises it bears to the state the same relation as any other business corporation. Whether municipally owned public-utility service be considered as belonging to either category, or as comprising functions in both, the grounds for state regulation are equally strong. This is a matter which should particularly interest the New England Water Works Association, as by far the larger majority of waterworks in New England are municipally owned.

Massachusetts, the first state going in for systematic public-utility regulation, recognized this principle in part and gave its Gas & Electric Light Commission the same authority in some matters over municipal plants as over private ones. The authority of the state boards of health of Massachusetts, New York, New Jersey and other states, over quality of water is without distinction regarding character of ownership. In England this stand has long been taken with regard to such features as accounting and reports. In at least one respect it has been carried further there than in any state in this country, for there municipally owned and operated utilities pay a property tax into the general treasury, just as other property does. The basic theory of this appears to be that consumers ought not to be relieved of a portion of their burden at the expense of other taxpayers, by having exclusive tax-free use of property, which seems logical and just in the light of the general principles that have been heretofore explained. But it is inconsistent with the English policy of allowing some municipalities to make considerable profits, applicable to the reduction of the tax rate.

Wisconsin, leader in the modern development of public-utility regulation, makes no distinction whatever between publicly and privately owned plants, and requires the same standards in both cases, for quality, accounting, rates, financial management, reporting, depreciation accounts, etc., etc.

Hon. John H. Reemer, Chairman of the Railroad Commission of Wisconsin, said in an address before the Trans-Mississippi Commercial Congress at Kansas City, in 1911:

> The distinctive feature of the law, however, in Wisconsin is that of placing all municipal plants under the supervisory powers of the Commission to the same extent as privately owned plants. The wisdom of this policy is no longer disputable, for no greater benefit has been bestowed upon the public by regulation of public utilities than that resulting from the operation of the law upon municipal public utilities.

This may be opposed by some of the ardent supporters of local self-government; but local self-government does not mean a right to local misgovernment. The rights of the citizen are just as much transgressed by a municipality which fails to fulfill its public utility duties as by a private corporation. As a matter of fact, regulation is sometimes even more necessary with a municipally owned plant than a private one; because people will often endure service and rates imposed upon them by their own town officers which would call forth vehement protest if a private company were involved.

Massachusetts was the pioneer in public-utility regulation, and has always led the country in the regulation of municipal accounting and municipal finance, making the most minute regulations with regard to some details. Nevertheless, it is interesting to note that the public-utility commission bill, presented to the General Court last winter (but not passed) held municipally operated plants subject only to the requirements of the sections on "Accidents," "Accounting," "Reports," "Appraisal," "Access and Inspection," and "Standards and Tests," and exempted them from orders by the Commission with regard to service, rates, or discriminations. The benefit to be derived from the law, which will doubtless be enacted in the future, will be greatly increased if this error is corrected.

Opinion is practically uniform in the desirability of commission regulation; but there is still discussion as to whether utilities should be supervised by municipal or state commissions. In the writer's opinion municipal regulation alone

*Abstract of a paper read before the New England Water Works Association, at Washington, D. C., September, 1912. The complete paper will appear in the "Journal" of the Association.

†Pittsburgh, Penn., and Birmingham, Ala.

will never be satisfactory. For municipally owned utilities such regulation is out of the question. In the case of privately owned companies, the pressure of local prejudice and feeling makes difficult the preservation of the judicial frame of mind and spirit of fairness, which are indispensable. In the case of a few large cities, high-grade city commissions have been partially successful. But even in these cases cities cannot afford expert service as extensive or of as high grade as is available when they act together through a state commission; and local commissions have not an equal opportunity to gain such varied experience or to accumulate so large an amount of data that may be applicable to future investigations and decisions. Moreover, the inter-corporate relations of most public utilities make effective local regulation as impossible in many cases as would be the regulation of interstate commerce by a state railroad commission.

It is believed, therefore, that a single state commission with ample powers and conspicuous responsibility will be most satisfactory. This does not mean that in the largest cities local commissions cannot be of great value in investigating local conditions in greater detail, and in collecting local information; but even if they do exist, a state commission is just as necessary to supplement them, and to secure in their work uniformity, equality, and efficiency.

In most communities, appointment of members to the state public-utility commission is the most satisfactory method of selection. Appointees should be men of wisdom, deliberation, scientific honesty, judicial temperament, breadth of view, and public spirit, with wide knowledge and experience in business, finance, economics and public service. Engineering and legal training are best adapted to secure some of these characteristics; but the qualifications mentioned are more essential than such a detail as professional training, and technical service can be secured by the employment of experts. The importance of the benefits accruing to the public justifies ample salaries so as to secure the services of the ablest men. Full power should be given to such a commission to investigate accidents, rates and service, to make valuations, to require uniform accounts and uniform reports, and control issue of securities and financial management, to require proper allowance for depreciation, to examine accounts and inspect property, and to make and enforce orders regarding rates, standards, service and discrimination. Full publicity in all matters is desirable. Future experience will show whether or not it is advisable to include provision for a modified form of the recall, such as is the novel feature of the Connecticut law.

It is still too early to form a final opinion regarding the results of thoroughgoing regulation of the Wisconsin type; but the tendency toward better service, better feeling between the utilities and the public, more equitable rates, greater stability of securities, and disappearance of discrimination and of corruption of local politics by franchise-seeking companies is unmistakable.

Some Features of Building Construction in New York City in 1911

The Spread of Fireproof Construction—The growth in fireproof construction is well evidenced by the figures of the Bureau of Buildings, Manhattan, New York City, whose report for 1911 gives the following:

FIREPROOF BUILDINGS ERECTED IN 1911, MANHATTAN

	Amount	Per cent. of all new buildings in Manhattan
Number of buildings	302	39.4
Ground area, sq.ft.	2,457,840	55.2
Floor area, sq.ft.	21,428,500	75.7
Cost, dollars	77,491,730	83.2

The above-given percentages are averages for the whole island. But in the portion lying between 14th and 96th Sts. the ratios of fireproof construction to total construction for the year are much higher: in number of buildings, 60%; in ground area, nearly 80%; in floor area, about 90%; and in cost of buildings, 95%. In fact, seven-eighths of all the fireproof new buildings erected during the year in the entire borough were located in this central part of the city.

It will be noted that only 28 dwelings were built in 1911, for a territory housing nearly 3,000,000 persons.

Heights of New Buildings—The 1911 records of building permits for Manhattan were for the first time classified as to height (in number of stories). The accompanying table resulted.

As the building code requires that all buildings over 75 ft. high shall be built fireproof, the "Ordinary Construction" stops at seven stories. Among business buildings, after deducting the large number of low structures (chiefly stables, garages and "taxpayers"), the height of 12 stories seems to be favored. Only 13 out of the total of 171 fireproof business buildings are over this height, and only two other new buildings are over 12 stories. Of the greater heights, 16, 20, and 25 stories seem to be preferred slightly.

Average Cost of New Buildings—The year 1911 showed a slight increase in amount and value of new buildings in Manhattan and Queens over 1910, and a decrease in the other boroughs; the total was a slight decrease over the preceding year. Nevertheless it is a representative year. For example, the total value of new buildings in Manhattan was 98½ million dollars, as compared with 95 million average for the past ten years; similarly, in alterations, the year's figure was practically identical with the ten-year average, slightly below 13 million.

For this reason the average cost per building for 1911 may be considered well representative of modern building customs in the central borough of New York City. During the last ten years the average cost varied nearly in the ratio of 1:3, being lowest in the period just after completion of the subway, when large numbers of apartment houses were erected, and highest in 1909, the year of greatest total building value but normal number of new buildings. The variation is from $48,500 (2572 buildings) in 1905 to $132,000 (995 buildings) in 1909.

In point of cost, alterations make up about one-eighth of the total value of building operations. They are considerably less variable from year to year than new buildings, both in number and in value.

The average cost per alteration in the past ten years is about $4000, though in recent years it has been only about $3500. It will be understood that the figures here do not include minor alterations and repairs, which are classed as "slip applications" by the building bureau authorities.

HEIGHTS OF NEW BUILDINGS APPLIED FOR, MANHATTAN, 1911.

Stories	Dwellings F.P.	Dwellings Ord.	Tenements F.P.	Tenements Ord.	Hotels F.P.	Hotels Ord.	Business F.P.	Business Ord.	Public F.P.	Public Ord.	Misc. F.P.	Misc. Ord.	Total F.P.	Total Ord.	Total
1							13	46	6	11	116	19	173	192	
2		2					6	41	9	9	2	15	54	60	
3		2				2	7	29	17	3		24	36	60	
4	4	4		1	1		5	11	8	1		18	17	35	
5	3	7		67	1		5	6	8	1		17	81	98	
6	2	2	1	71			14	17	2			19	90	109	
7	1						15	13	2			18	13	31	
8	1		9		1		22		3			36		36	
9			10		1		4					15		15	
10			7				4		1			12		12	
11			1				7		1			9		9	
12			25		3		56		1			85		85	
13															
14							1					1		1	
15															
16							3					3		3	
17							2					2		2	
18							1					1		1	
19									1			1		1	
20							3					3		3	
21-25					1		2					3		3	
Over 25							1					1		1	
Total	11	17	53	139	8	2	171	163	59	25	118	302	464	766	
	28		192		10		334		84		118				

Note.—F.P. means Fireproof. Ord. means ordinary construction.

An Interesting Exhibit of Progress in Transportation

In connection with the celebration of the Semi-Centennial of the Loyal War Governors' Conference of Sept. 24, 1862, recently held at Altoona, Penn., the Pennsylvania R.R., whose great locomotive shops are located in that city, exhibited by a series of floats five historic steps in transportation methods.

The first of these floats, shown in the accompanying illustration (Fig. 1), is an old-time Conestoga wagon, the type of conveyance by which freight was transported over the early turnpike roads of Pennsylvania, and by which many hardy Pennsylvania emigrants wended their several ways to the wilds and forests of Kentucky and Ohio, and the prairies of Illinois and Iowa, in the first two decades of the 19th century.

The next illustration (Fig. 2) shows the float carrying a reproduction of one of the first canal "packets" which plied on the Pennsylvania Canal in the days when it was confidently believed the limit of luxury in cross-country travel had been attained.

The illustration in Fig. 3 shows a reproduction of the famous "John Bull" locomotive and a passenger train of 1831. The history of the "John Bull" was given in ENGINEERING NEWS of Jan. 18, 1890, from which we note the following: It was built by Robt. Stephenson & Co., at Newcastle-on-Tyne, in 1831, for the Camden & Amboy R.R. Having arrived at Philadelphia it was packed into a sloop and transported to Bordentown, N. J., where it was loaded on a wagon and hauled to the track, then about three-quarters of a mile long. The first public demonstration was made on Nov. 12, 1831, in the presence of the entire legislature of the State of New Jersey. This was within a year of the time when the first American locomotive, the "Best Friend," was tried on the South Caroline R.R. (Jan. 15, 1831).

The "John Bull" was used occasionally to as late as 1866. It was exhibited at the Philadelphia Centennial in 1876 and at the Chicago World's Fair in 1892-93, when it made the trip from New York to Chicago and from Chicago to Washington under its own steam. It is now in the National Museum at Washington.

The other two floats represented the first steam train to the West, in 1834, and the first passenger car with an elevated roof, built in 1836.

The Development of Electric Circuit Breakers*

BY E. B. MERRIAM†

The demands of modern economic conditions have called for the concentrated production of electrical energy in large central stations. The control of this energy has presented many new problems in the design of protective devices, chief among which has been that of the automatic interrupter of abnormally loaded electrical circuits.

*From the "General Electric Review," September, 1912.

†Assistant Engineer, Switchboard Department, General Electric Co., Schenectady, N. Y.

For many years oil circuit-breakers and fuses were used with good effect on direct-current systems. When used on heavy-power alternating-current circuits connected to transmission systems, however, these devices set up line disturbances difficult to suppress. The large flaring arcs were also objectionable through their liability to involve adjacent apparatus, and on account of the great amount of room necessary for their proper isolation. Tests were made to find a suitable circuit-interrupting device for use on large-capacity systems. The various schemes tried included an air-break switch; a gravel switch; a switch in which an insulating shutter was thrown across the gap in order to shut out the arc; a lightning-arrester switch, in which the principle of the non-acring multigap arrester was employed; a tube switch, in which a plunger in descending drew an arc into a tube with an opening at the top, the pressure developed in the tube blowing the arc out through this opening; a switch in which a blast of air was blown across the contacts, thus lengthening out and rupturing the arc; and switches having an upward or downward break in a

FIG. 1. CONESTOGA WAGON—THE CONVEYANCE USED BY THE PENNSYLVANIA PIONEERS OF 1812

FIG. 2. MULE-POWER "PACKET" OF THE PENNSYLVANIA CANAL OF 1830

suitable oil. Of these various devices, the most efficacious was found to be that in which the circuit was opened in oil.

The investigators, having found that an oil-break circuit interrupter was the most suitable, next turned their attention to finding out the most suitable type of oil circuit-breaker. With this end in view, they experimented with knife blades in oil, with drums similar to railway controllers, and with rods having a vertical or horizontal movement. This led to the development of a lever switch immersed in oil, which, for several years, remained the most efficient type of oil-break switch. As capacities increased, however, the limits of this switch were soon reached; and, as a result of the previous tests, there was developed a switch having a double downward break in oil. The stationary contacts of this switch were spring fingers, and the moving element was a bridging contact which connected the stationary ones when the switch was closed. This device had advantages in that the contacts cleaned themselves each time the switch was operated; that there were a minimum number of points to be insulated from ground; and that the stationary contacts, when the switch was open, were always insulated from each other by a clean layer of oil, since as they were located near the top of the oil-vessel, most of the moisture and dirt in the oil gravitated to the bottom. The main advantage of this switch, however, was that it was possible to remove the oil vessel for inspection of the contacts and renewal of oil without disturbing any other portion of the switch, particularly the connections. This switch as initially developed was in service on circuits up to 6600 volts and is still effective. The time soon came when transmission voltages began to pass this point and rendered necessary the development of switches for use at higher voltages on larger systems.

A radical departure was early made in the design of the oil circuit-breaker. For controlling the larger-capacity circuits which were first encountered, investigations were made on a double upward-vertical-break switch, in which each break was made in a separate compartment. The first commercial device consisted of cylindrical oil vessels, rather short for their diameter, in which the rods moved vertically upward, and in which the oil-chamber was practically sealed from the outside air. Owing to the air-tight nature of the oil vessel, operating difficulties were experienced; and the next step was to open the oil chamber to air, placing suitable oil diverters in the top of the oil vessel so as to deflect any oil which might be thrown out due to the opening of the switch and the formation of an arc. With increased generating capacities it was found that this switch at times ejected a quantity of oil, and it was next necessary to provide a suitable air space in the top of the oil vessels to act as a buffer. Besides this, an increased vent space was found necessary so that the air on top of the oil could be readily renewed, thus preventing the formation of explosive mixtures.

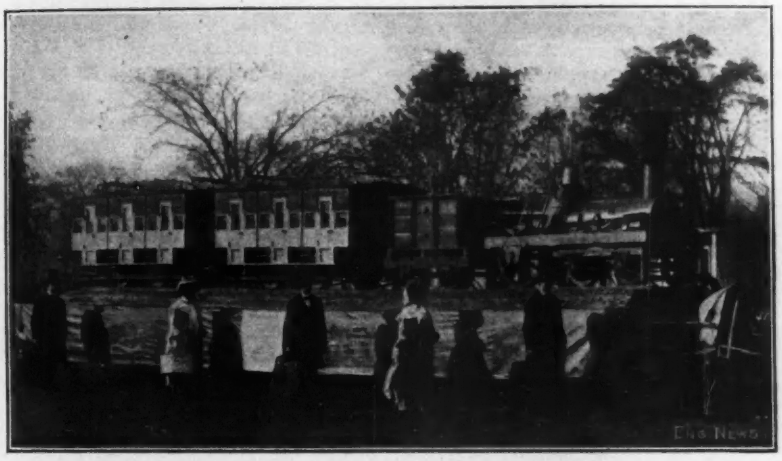


FIG. 3. THE LOCOMOTIVE "JOHN BULL" AND A PASSENGER TRAIN OF 1831

The maintained increase in generating capacities soon overtook the developments in oil circuit-breakers, and necessitated an additional investigation to increase the capacity of the device. As a result there was developed a baffle plate for the vertical upward-break type of circuit-breaker. The function of this device was to keep the oil in the neighborhood of the stationary contacts, for whenever an electrical circuit carrying considerable energy is opened in oil, gases are generated. These expand and rise, and tend to force the oil out of the containing vessel. They also form with air explosive mixtures, and either explode, or burn for a considerable length of time when ignited. It is seen, therefore, that oil circuit-breakers must be provided with strong oil-containing vessels in order that they may withstand the high initial stresses which are often present under certain conditions, and also that suitable provision be made for retaining the oil.

This type of switch remained standard for large-capacity systems for a number of years. The advent of the steam turbine-generator, with its greatly diminished internal reactance and correspondingly increased short-circuit current, increased the short-circuit current of systems beyond the capacity of this circuit-breaker. To meet the new condition, further investigations were made, and suitable oil-diverting devices were introduced into the oil vessels. This practically doubled the capacity of the oil-circuit breaker and, together with structural changes in the design of the oil vessel, made the highly developed large-capacity oil circuit-breaker of today for use on moderate-voltage systems.

The present indications are that the oil circuit-breaker will not be developed very much further along the lines at present being followed; but that, for the control of very much greater capacities than at present found, some new lines of improvement will be necessary. At present it is proposed to take care of these greater capacities by subdividing the generating units into groups of less than 50,000 kw. It is not possible to apply it to all systems owing to the diversity of the loads which they carry, together with their method of distributing power. Another proposal is the introduction of current-limiting reactances, not only into the generator circuits, but also into the feeder circuits.

In the above outline, mention was made of the increase in the capacities of systems, reference being made principally to those of moderate voltage. At the same time the pressure of transmission lines has been gradually increased, until a point was some time ago reached beyond which the developed circuit-breakers were unsuited for the control of circuits of higher voltage. To meet the need for a circuit-breaker for use on high voltage systems, a research was made for developing proper methods of insulating the terminals of oil circuit-breakers. Early investigations in connection with a 40,000-volt installation disclosed the fact that, for this pressure, wet-process porcelain made a suitable bushing; although it was found that simply increasing the dimensions of a porcelain bushing would not take care of the higher voltages soon to be encountered. The problem involved in designing a bushing is different from, and more difficult than, that of designing an insulator. It has been found that, owing to the electrical constants of these materials, no great benefit is derived from increasing the thickness of insulation, due principally to the uneven distribution of the electric potential. The

result has been the development of two radically different types of bushings for insulating the leads of oil circuit-breakers. One of these is the so called condenser lead, originating in Germany, and the other the filled lead, a product of this country. These two bushings represent the results of a great deal of research in attempting to overcome the obstacles imposed by the very high voltages now used on long-distance transmission lines.

Other features of high-voltage circuit-breakers are their huge size and the great amount of oil necessitated by the requirements of insulation. It should be noted that oil circuit-breakers for use on circuits of moderate voltage have their overall dimensions usually fixed by the energy of the circuit which they control. Those for high voltage, however, have their size fixed principally by the insulation value of the mediums used in the construction of the device and the factor of safety required. At present it has been found advisable to use principally air and some insulating liquid such as petroleum oil for the insulation between ground and bare contacts of the circuit-breaker.

It is thus seen that modern oil circuit-breakers are the result of extensive research, undertaken in order to meet the demand for apparatus which will efficiently and safely control the output of large electric stations.

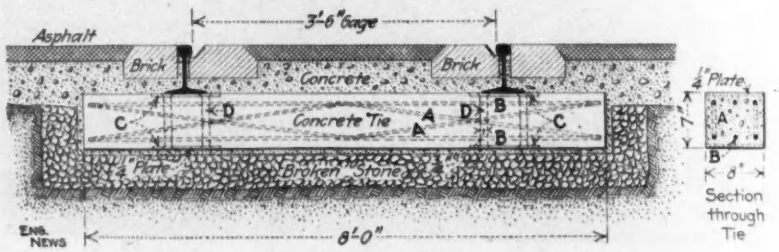
Reinforced-Concrete Ties for Street Railway Track

By LeRoy W. Allison*

During the past few years the Los Angeles Ry. Co., of Los Angeles, Calif., has been thoroughly testing the possibilities of a special design of reinforced-concrete tie. The streets on which the ties have been laid (Spring St. and Broadway) are the main arteries of the company's system and are subjected to a traffic of approximately 2800 cars daily. The ability of this type of tie to render effective service has been so marked that the company has announced its intention of adopting the tie for general application on its lines.

There are many features which recommend the employment of this class of tie. They offer solidity and permanency, and have long life. They effect a large saving in the cost of maintenance, eliminating the necessity for constantly tearing up streets for the replacing of ties and the consequent interference with traffic. They give smooth running of cars, and with less noise than on wooden ties. The track sections with reinforced-concrete ties which the company has had in service for over two years are found to be in perfect condition, showing no signs of wear. The initial cost is slightly in excess of that of a good wood tie, but the results obtained more than counteract the difference. The company bases its decision more on ultimate cost than first cost. The average life of a wood tie in the ground is from 3 to 5 years,* while a low estimate of the life of the reinforced-concrete tie would easily allow from 25 to 30 years. The replacing of wood ties, neglecting the scarcity of such ties, is but a small part of the expense of the rebuilding of the line. With the concrete ties the cost of maintenance is practically limited to the renewal of the rails every 7 to 10 years, in which case only the paving on either side must be removed to effect the work. It is readily seen that the cost is reduced to a minimum.

The type of reinforced-concrete tie used, and the method of track construction are shown in the accompanying cut. The tie is 7x8 in., and 8 ft. long. It is reinforced longitudinally with six twisted rods, the crossed bars *A* being on either side, while the straight horizontal bars *B* run through the center. These rods are wrapped with galvanized-iron wire. Two ¼-in. wrought-iron tie-plates *C* are placed on each side of the tie as shown, and the rails are fastened to two pieces



Street Railway Track Construction with Reinforced-Concrete Ties; Los Angeles, Calif.

of ¾-in. steel tubing *D*, which are imbedded in the concrete and used as sleeves for the tie spikes. The spikes are ⅝ in. square, and are firmly socketed in the tubing when driven by heavy sledge hammers. With this method, as is evident, the spikes never reach the concrete body. Fastening the rail to the tie has heretofore been one of the chief difficulties in using a reinforced-concrete tie, but by this means the difficulty appears to have been overcome.

The concrete used is a 1:1:4 mixture, using stone which ranges in size from screenings up to 1 in. The weight of the tie is about 250 lb. The ties are cast in wooden molds at a manufacturing plant the company has built for the purpose. After pouring the concrete, the ties are subjected to heavy pressure and allowed to set a few weeks (or longer) before being placed in service.† The entire manufacture of the tie is a very simple process.

When placed in position, the ties rest upon a foundation of broken-stone ballast, with a concrete top covering, as shown. A concrete base is also supplied for the asphalt street surface between the outside of the rails. Paving bricks are laid on each side of the rails, those on the inside being chipped to suit the rail and form the flangeway. While T-rails are shown, and have always been used by the company, a recent city ordinance requires that the grooved section, or Trilby rail, must be installed hereafter on paved streets in the city. On Spring St., the rails are of 87-lb. section. The construction on Broadway, which is exactly similar, has 116-lb. rails to provide for the greater traffic.

To show the strength and elasticity of the reinforced-concrete tie over the ordinary wood tie, a test was made with a concrete tie and a wood tie (both 7x8 in., 8 ft. long) connected together at the ends by chains and having a hydraulic jack set between them. During the test the concrete tie deflected ¼ in., resuming its former state upon the fracture of the wood tie.

These ties are the invention of E. D. McDonald, Los Angeles, Cal., and are covered by patents. The Los Angeles Ry. has acquired the rights to manufacture them for its use, and (as mentioned) has established its own plant, at which they are being made at the rate of about 100 per day. The difficulty in finding a practical reinforced-concrete tie that could be manufactured at a nominal cost seems to have been eliminated, when this tie is costing from $1.15 to $1.25, ready for service. The cheapest standard wood tie costs approximately 60c. in Los Angeles, while ties of selected stock range up to $1.50.

[From C. A. Henderson, Assistant General Manager of the street railway company, we have the following additional information, furnished in reply to our inquiry. The life of wooden ties is 7 to 15 years, and the life of concrete ties is estimated at 30 years. The number of the concrete ties already in use is a little over 8000; they are spaced 30 in. apart, while wood ties are spaced 22 in. The depth of the bed of broken stone under

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*In reply to our inquiry on this point, the railway company gives the life of wooden ties as 7 to 15 years.—Ed.

†We are informed, however, that instead of any heavy pressure on the ties the concrete is simply rammed by hand in the forms.—Ed.

the ties is 6 to 8 in., and the thickness of the concrete between the ties is 6 in. The spikes are found to hold tight in the steel tubes.—EDITOR.]

Proposed Specifications for Hollow Clay Tile Building Blocks; End Construction

BY VIRGIL G. MARANI*

The article on specifications for hollow clay tile contributed by the writer to ENGINEERING NEWS, Feb. 8, 1912, p. 248, referred particularly to building tile of the interlocking type, and to the side construction method, viz., when the tile are laid with their voids horizontal in wall construction. At the close, it was stated that if it was desirable to use tile laid with voids vertical, a specification regulating this type of construction should be adopted. The present article is intended to cover that field.

When laying building tile on their sides (voids horizontal) the material is used to the poorest advantage from the point of crushing strength, for the reason that tile, when so laid, bring into use the smallest amount of square inches of available web section. Again, tile somewhat resembles wood or other fibrous material, which is always weaker to crushing stresses when these stresses are applied at right angles to the grain instead of with the grain, or parallel to it. A microscopical examination of tile will show that this grain is in the direction of the tile as it was pushed through the molds in manufacture.

Certain tile with an interlocking feature were manufactured near Cleveland, and the specifications given in the previous article were intended to govern and control this particular type of tile.

It was suggested that vertical webs should be spaced not more than 4 in. apart, and that their thickness should not be less than one-fifth of their height, because of the recognized fact that tile laid on its side does not develop the same crushing strength as when laid on its end. The bedding, it was suggested, should be limited to about 4½ in., for the reason (as the diagram showed) that in interlocking tile, whatever may be gained in stiffness against buckling by their interlocking feature, is offset by the manifestly impossible condition imposed upon the mason, viz., that of making two mortar joints on different levels at the same operation.

Since mortar joints shrink in proportion to the thickness of joint and the composition of the mortar used, it will readily be seen that a wall laid up with interlocking tile, to have the maximum strength, must be laid with the tile face perpendicular, and at the same time the joints of these two beds must be absolutely the same thickness.

If any of the T-shaped or interlocking type of tile be laid upon the floor in the position intended for it to be laid in the wall, it will be noticed that it will not stand perpendicular, but will immediately fall over owing to the fact that the center of gravity of its mass lies outside of the base. This action, or tendency to tip, takes place when laying up a wall, one tile tending to tip out and the next tile tending to tip in, with the result that the mortar used, being of the same consistency for both beds, is squeezed more in the one bed than in the other and *vice versa*. Therefore we may safely assume that whatever is gained by the interlocking feature of this type of tile is more than lost in the fact that they are laid horizontally (in the weakest position) and that the finished wall contains mortar joints of unequal thickness and compression.

Another objection to the use of many of the types of interlocking or side construction tile occurs in the piers between windows on account of the end openings being exposed. Water will also be more readily conveyed toward the inner shells since the webs are horizontal and continuous, and in many of these tile every alternate joint running through and down the wall adds another medium for the passage of water.

The above objections do not apply to the end-construction method, for the following reasons: There are no end openings. If water should get through the outer shell by careless jointing or improper workmanship and poor tile, it would quickly be carried down the outer shell to the footing, that being the course of least resistance. The vertical joints not being filled solid with mortar (a space of 2 in. or more being left in the middle of the wall) all possibility of water travel through this medium is prevented. Good construction of window sills and caps can be accomplished with tile covered with stucco, but if desired, nothing prevents the use of stone or artificial sills from the standpoint of a good mechanical job.

For well proportioned bearing walls, etc., the writer advises laying tile on end, or with voids vertical, and this applies also to tile-floor construction, though in both cases care should be taken to construct so as to have web contact. Where a combination of end and side construction is used, the carrying capacity of the wall is reduced to the strength of the crushing load of the tile loaded when laid on their sides.

The superiority in strength of the end construction is shown in the recent tests on hollow tile walls reported in ENGINEERING NEWS, June 20, 1912, p. 1181, and Aug. 15, 1912, p. 294.

It is an acknowledged fact that every pound of material entering into the construction of a building which does not add to its strength, is detrimental to the structure. For this reason and on the evidence of the past these tests which show a greater compressive value for tile than for ordinary brick laid in lime mortar, the writer would recommend that tile should be more extensively used for building walls and curtain walls, etc., where the lightest wall possible is desired consistent with the necessary strength required.

The tentative specifications for hollow clay tile laid on end for building blocks are as follows:

TENTATIVE SPECIFICATIONS FOR HOLLOW CLAY TILE WALLS SET ON END

1. QUALITY. Tile are to be made of hard burned shale or fire clay, or any clay that will burn to a good dense body without undue warping or checking, and must be burned to such a degree of hardness that they will not absorb more than 12% of their weight in moisture. The tile should be true and free from injurious checks and cracks. Vertical webs should be spaced not more than 5 in. c to c, and should have a thickness of not less than ½ in. for interior webs, and ⅞ in. for exterior shells. The height of these blocks shall not exceed 12 in.

2. USE. Terra cotta hollow tile may be used for bearing walls four stories or less in height, or for inclosure walls for skeleton structures of any height where the wall is carried at each story on steel or concrete beams or girders.

All walls exposed to weather, if of hollow tile, must be of dense material, or they may be hard burned and covered on the exposed sides with at least 1-in. portland cement stucco.

3. LAYING. The tile should be so laid in the wall that all vertical webs which are parallel to the face of the wall shall be in vertical alignment with the vertical webs of the adjacent tile below.

Bedding shall be made with cement mortar composed of one part of portland cement, three parts of clean, sharp sand, and if hydrated lime is used, not more than 10% shall be included.

Vertical joints shall be well buttered with the above mortar before the tile are laid, for a distance of about 3 in. from both interior and exterior faces.

4. LOADING. The loading of hollow tile when laid on end shall not exceed 400 lb. per sq.in. of net area in compression.

5. WALLS. The thickness of walls shall be the same as prescribed in the City Building Code for brick walls, and shall be subject to all conditions relating to increase of thickness necessary by the height or length of walls, or both.

6. FACTOR OF SAFETY. The ultimate crushing strength of tile when laid on end shall not be less than six times the load they are required to support.

Highest Daily Steamshovel Record—Steamshovel No. 120 (T. P. Kelleher, engineer, and L. P. Bonnell, craneman), working in the west borrow pit for Gatun Dam, loaded 202 large Oliver dump cars containing 3434 cu.yd in the working day of eight hours on July 6. This is 119 cu.yd. more than the previous daily Isthmian record for a 70-ton shovel, made by the same shovel and crew on April 2, 1912.—"Canal Record."

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The Commercial Development of Chemical Engineering Processes*

By Jasper Whiting†

There is an old proverb that reads, "It is a wise father that knows his own child." If this proverb be paraphrased to apply to chemical processes one might say, "It is a wise scientist who knows his own invention"—after it has achieved commercial success. Like the properly reared small boy, it has been coddled and fostered, encouraged and controlled, whipped into shape and tested in the school of experience, until it has come out a man in stature, containing the blood of its birth, but very different in appearance, character, and efficiency. And just as each child, though different from every other child, must pass through certain definite stages in his physical and mental development, so, I think, chemical processes, though varying one from another in character and detail, must pass through somewhat similar stages.

I feel a certain hesitancy in approaching this subject, for I realize that I am speaking to men who have had far greater experience than I as parents of processes. Bachelors and spinsters proverbially talk glibly on the training of infants. Still, though I am less experienced than most of you, I refuse to be classed with such benighted persons, for I have had two wayward children of my brain, who have lived to achieve manhood, but not without causing their devoted father more trouble and heartburns than they can ever repay with dividends.

The two processes to which I refer, both of a chemical nature, were of very different characters. The first related to the manufacture of cement from blast-furnace slag. This was conceived in 1895 and developed under my direction until 1901, when a plant costing approximately half a million dollars was placed in successful operation. The second process related to the electrolytic production of chlorine and caustic alkalis. This was conceived in 1905 and was developed under my direction till 1911, when a plant costing one-quarter of a million dollars was placed in successful operation. The development of each process occupied, therefore, approximately five years, and, though the two processes were very dissimilar, one being a chemical engineering and the other an electrochemical engineering problem, the means taken to achieve the final results, the periods of evolution, were much the same in each instance. It has occurred to me that it might be helpful to some of the younger men of our profession if I were to set down a few of the more important steps in the evolution and make some observations thereon.

Chemical processes may be divided into two general classes: First, those that are purely chemical, that have to do with a formula or reaction and little else; and, second, those that are chemical in principle, but require the use of special apparatus in order to carry them out. With the first class I have had little experience. My remarks, therefore, refer only to chemical processes of the second class, those that are more truly chemical-engineering problems than problems in pure chemistry.

The evolution of chemical-engineering processes may be divided into five distinct stages, the function of each being different from that of any of the others, though all the stages overlap to a greater or less degree. These stages may be designated as follows:

First. The Beaker or Laboratory Stage.
Second. The Small-Sized Model.
Third. The Life-Sized Unit.
Fourth. The Semi-Commercial Plant.
Fifth. The Commercial Plant.

As I have said, each stage is distinct from all the others. Each has its own importance, and none should be slighted. Experience has shown that as a rule he who tries to jump, say, from the first or second stage to the last lands in the ditch of failure. It is the purpose of this paper to discuss these stages separately, and to point out the special function of each.

First, the Beaker or Laboratory Stage. It is the function of this stage to prove the correctness of the chemical principle involved, the novelty of the process, and its commercial soundness.

The inventor is proverbially an impractical optimist. He is inclined to think that the idea which emanates from his fertile brain represents from 90 to 99.9% of the full value of the commercial process. In my opinion the original idea is seldom worth more than 10% or even 5% of the finished process, the remainder representing development work and money. But, of course, the idea itself is an essential to success, just as are the other elements which go to make up the final result. It is important, therefore, that the idea be clarified before much money or time is spent in developing it.

The first step in this direction is to conduct such experiments as may be necessary for a full preliminary study of the technical side of the problem in hand. It is not the function of the laboratory to produce accurately the condition of practical work, but rather to enable the experimenter to test out fundamental principles on a small scale with a correspondingly small outlay of time and money. The aim should be, therefore, to isolate the idea, to divorce it from any conditions which may be misleading in their effect, and also to subject it to severe strains to determine its pluck and endurance. Moreover, the experiments should include a study of the underlying causes of the defects in existing competing processes, and their extent and importance. This study of the technical side of the problem is necessary as an insurance against useless work.

But the function of the first stage is not ended here. The novelty of the process must likewise be investigated by a thorough study of the state of the art in textbooks, periodicals, and Patent Office records, an undertaking which requires time and patience and not a little self-control. In the investigations of the Whiting Cell more than a thousand references were found, classified, and catalogued.

And just as important as the search covering the novelty of the process is a study to determine whether the basic commercial conditions surrounding the process are sound, that is, whether the raw materials required are to be obtained at a reasonable price and in sufficient quantities; whether the operation is likely to involve any extra hazardous conditions, and whether there is a permanent market of sufficient size and stability for the product. From a practical standpoint it is useless to spend time and money on a process not commercially sound, but this is being done constantly by inventors all over the world. I have personally known of several cases where men have spent years developing a secret process, only to find in the end that the market conditions were unsound, a fact easily ascertainable in the beginning. When these three factors have been determined, viz., the correctness of the principle involved, the novelty of the process, and its commercial soundness, it is time to write out a full description of the invention, with attached sketches showing diagrammatically the important points, and this description should, of course, be dated, signed, and acknowledged before a notary public. Except under very unusual conditions I believe a patent should not be applied for during this stage.

Second Stage, the Small-Sized Model. It is the function of this stage to determine the best conditions of operation.

Such a problem as is being considered presupposes the use of a special apparatus in which the process is to be carried out. It is now time to construct such an apparatus, and in designing it the aim of the inventor should be to model it, without special reference to the final form of the device, with the idea of obtaining an apparatus in which the process may be worked under a great variety of conditions. In other words, the model should be as flexible as possible. For instance, in the original design of the model of the Whiting Cell, the compartments in which the salt is decomposed and the amalgam oxidized

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were made independent of one another, and in such a way that the dimensions of each and the relationship of one to another could be varied independently within wide limits. By this means, with a single model, we were able to determine the proper size and shape of each compartment, their relationship, and the most effective method of operation. It is interesting to note that in this instance the results obtained with the first model have had permanent value. This is not always true. By operating the apparatus under a great variety of conditions, the best procedure can be ascertained and the scope of the invention determined within the limits of the experiments performed.

The small-sized model, moreover, should be big enough to permit the manufacture of a sufficient quantity of the product to enable the experimenter to determine its quality. In the laboratory one experiments generally with pure chemicals. In the small model it is well to use commercial materials, the impurities in which often are disturbing factors in the success of the process. As regards the final efficiency of the process under actual conditions of plant operation, very little of value can be learned from this model, but much knowledge may be obtained which will aid in the design of the final apparatus and in determining the choice of materials to be used therein. It is well that the work of this second stage be conducted by the inventor himself or, at least, under his supervision.

Third Stage, the Life-Sized Unit. It is the function of this stage to determine, so far as possible, the final design of the apparatus.

We all know that chemical processes, of the class that is being considered, depend as much upon mechanical or electrical details as upon the chemical principle involved. The average inventor of such processes is first of all a chemist, and as such often underrates the importance of engineering as a factor in his work. It is because of this, because of the fact that the chemist fails, for one reason or another, to seek the aid of an engineer at this critical period of his work, attempting to design and superintend the construction of the Life-Sized Unit himself, that many processes, if not wrecked, are at least greatly delayed in their development. It is no disgrace if a man does not embrace within himself all the knowledge of all the arts. If he is really proficient in one branch of one of the arts or sciences he need not be ashamed to hold his head high. The business man does not attempt to draw his own contracts, but calls in an attorney for that purpose.

Doubtless he could acquire the necessary knowledge to draw these contracts if he gave proper attention to the study of law, but, as a business man, he finds that it is economically to his advantage to concentrate his efforts within his particular field and to call in specialists for special work. Personally, this is the plan that I have always adopted, and much of whatever success may have attended the processes which bear my name is due to the various engineers who from time to time have helped me. Thus the development of the cement process was greatly facilitated by the engineers of the Illinois Steel Co., notably J. G. Bergquist, of Chicago; and the Electrolytic Cell had the benefits of the criticism and advice of William Hoopes, of Pittsburgh, and Prof. C. F. Burgess, of the University of Wisconsin. I am glad to have this opportunity to acknowledge my indebtedness to these gentlemen.

The proper design of the Life-Sized Unit, of course, is of the highest importance, but even if constructed after careful thought and with best advice it is apt only too often to fail to fulfill completely the expectations of the inventor. Flexibility of arrangement, therefore, should be borne in mind in order that changes may be made in the design as occasion warrants. Moreover, the old model should not be discarded as soon as a defect becomes evident, but should be retained until all of its weaknesses are known.

The tendency of the brilliant young inventor, whose ideas come thick and fast (or, rather, thin and fleeting), is to discard his first apparatus the moment he sees that a detail of it can be improved, and proceed to build a new type which will apparently do the work better; but more often than I care to predict he will find that the old apparatus had virtues which the new one does not possess, and if he retains the old while he develops the new, he will be able later to build a third type which will combine the proven good points of each. "Hold fast to that which thou hast" is a proverb which might appropriately be nailed solidly over the desk of every inventor.

The tendency to hurry over the third stage in the evolution of a process is often almost overpowering. After a few weeks or a few months, as the case may be, the operation of so small a plant becomes tedious, and the inventor is apt to chafe at not being able to make more rapid progress. It is evident, however, that defects are much more easily remedied on a single unit than on a great number of units, and the more perfect a process emerges from this stage, the shorter and easier will be the subsequent stages, and more complete the success. Moreover, many chemical processes which work well on a small scale are failures on a large scale.

Thus, in the development of the Electrolytic Cell, the provision made for decomposing the amalgam in the oxidizing compartment, though perfectly satisfactory when applied to the small-sized model, proved inefficient and unreliable in the Life-Sized Unit, necessitating much research work and a re-design of the apparatus before the defect was overcome. Likewise, many processes have defects that may be called accumulative. I have known a piece of apparatus to work well for a period of seven months, and at the end of that time develop a defect which made it practically useless.

One instance of the result of accumulative troubles is still a clear and tragic memory with me. We had been experimenting for some time with a new process for producing simultaneously three products, two of which were stable if separated one from the other, but if brought together formed an explosive mixture. For a number of months everything had operated well, until at last a gentleman, who had heard of the process and wished to investigate its merits with a view to its purchase, wrote for permission to visit the plant. Great preparations were made for his reception. The floor was swept as clean as the proverbial whistle, the bottles and windows were washed and polished, and the records of the past months' work plotted in all their detail to form beautiful and convincing curves.

At last our visitor arrived. I can see him now as he walked into the room, a cheery smile upon his face and on his legs a brand-new pair of trousers. With poorly counterfeited modesty we showed him our apparatus, watching narrowly to see if he were properly impressed. Suddenly there was a tremendous explosion. The air was filled with flying cement and glass. Scalding hot liquid was shot upon us as from a spouting geyser. There was a vision of an unfamiliar figure "beating it" to the door, his clothes steaming, his face a study in terror and disgust. The whole apparatus had blown up, and with it went our hopes of a quick reward for our labors. There was not enough of value left in the room to pay for a ruined pair of trousers.

What happened was this: slight quantities of the two iniquitous products of our process had for a long time been escaping to a bell-like chamber reserved for other things, until, at the psychological moment, a ray of sunlight through the newly washed windows caused them to unite with direful results. The evident moral of all this is, "Never wash your windows."

The Life-Sized Unit should be tested and tested and tested again. It is not alone necessary to determine how well it will operate under ideal conditions, but how it will withstand the hard knocks of practice. Any ship will make good progress with a fair wind and a following sea. The apparatus should be overloaded until it actually breaks down. The brain of the experimenter should be racked to devise new means of punishment, new methods of multiplying a

hundredfold the severities of actual use. This is the shortest and surest way of determining the pluck, endurance, and foolproof qualities of the device. It is Edison's method, and he, of course, is a past master at the game.

In my opinion a patent covering the invention should not be applied for until the third stage is about 80% completed and the experimenter knows with reasonable certainty that his process will work and that his apparatus has permanent value. A patent drawn at this period is sure to be of real worth. As the idea has passed through the three preliminary stages it has undergone modifications and changes. Now, however, it is a well formulated, definite, practical fact, a thing to which the inventor is properly entitled to protection. Such a patent is almost always obtainable and seldom vulnerable. The invention has been developed logically and as rapidly as systematic work would permit; therefore it is unlikely that others who started later have overtaken the experimenter in this particular field.

Ideas hastily formulated and lightly patented seldom are sufficiently complete to be of value; consequently, interference from them is not to be greatly feared, especially if the statement of conception, made and recorded at the end of the first stage, is available. Before the patent is issued, the third stage will have been completed, the design of the apparatus determined, its efficiency and durability demonstrated, and the construction of the Semi-Commercial Plant begun.

Fourth Stage, the Semi-Commercial Plant. It is the function of this stage to determine the efficiency of the apparatus when operated in multiple, and its relation to the necessary auxiliary equipment.

At the beginning of this stage it is necessary to consider a new and very necessary element for success—money. The first three stages consume large amounts of time and energy, but comparatively little hard cash. Now, however, a considerable sum will be needed to carry the process through the fourth stage. Of course there are many ways of proceeding to get this money, and conditions must govern the final analysis, but I would suggest that there are advantages in the erection of this Semi-Commercial Plant in connection with some going concern, giving certain limited rights to use the process, if successful, in consideration of the opportunities and equipment furnished. Generally this is a safer and more economical arrangement at this stage than to attempt to form a company for the exploitation of the process and the erection of a small independent plant. The well oiled machinery of the allied concern, its purchasing department, its engineers, its laboratory and workmen, will all be available for the new work, leaving the experimenter free to concentrate on his own special problems.

In the designing of the Semi-Commercial Plant, flexibility of arrangement as regards the auxiliary apparatus should once more be borne in mind. For this reason hand labor is better than machinery for moving materials, and a number of small motors better than shafting for primal power.

The proper size of this plant depends, of course, upon individual conditions. It should be as small as possible, and still be able to produce enough of its product to permit the testing of its quality under the conditions of actual use. It should be large enough to indicate something of the cost and quality of the labor required for the commercial operation of the process. The Life-Sized Unit was looked after by skilled men. It is now necessary to prove that the process may be operated by ordinary cheap labor.

Moreover, the plant should contain a sufficient number of units to enable the experimenter to determine their efficiency under the average condition of plant operation. A single unit may do very good work when petted and pampered by constant adjustments, but give it its place in a series of units all subject to the gruelling test of "average conditions" and it often falls down. Much can be learned from this little plant, especially as regards the general arrangement of the large plant and the relation of one piece of apparatus to another. These are important points, which affect not only the first cost of building the final plant, but also the cost of its operation over an extended period of time, and both factors will aid greatly in obtaining the full measure of benefits to be derived from the development work.

Fifth Stage, the Commercial Plant. The conditions to be considered in connection with this final stage are too many and too obvious to be spoken of in this paper. I would only suggest that the plant be laid out on a large and comprehensive scale, but on the sectional basis, and only one section built at first. If this section operates successfully the development work is over and the process has reached the Promised Land.

The true scientist who makes investigations for the love of science cares little for the protection of his discoveries. His mind does not concern itself with patents. He desires only to add to the general store of knowledge, to wrest new secrets from Nature for the benefit of his fellowmen. He should not forget, however, that if his invention is to become useful to a large number of people, which is the final object of his desire, there must be some inducement offered his less altruistic brothers to take up its commercial development, and this inducement, as a rule, is obtained only through the Patent Office.

The average man does not pursue development work except with the hope of material gain. That this view is a proper one is recognized by the community at large, whose laws pronounce that an inventor is entitled to protection and to the fruits of his labor. It is a common belief that the obtaining of a patent procures this protection. This, of course, is by no means true.

A patent is not a protection until the process or device which it covers is proved to be the invention of the patentee, and this proof is established only after the Court of Last Resort has passed favorably upon it. It is, therefore, little more than a record of work done, and is seldom worth the expense necessary to prove its value. The experienced inventor, therefore, does not rely exclusively upon patents for protection. It is well to patent certain features of the process after they have become firmly established, or certain features of the necessary apparatus, but it seems to me almost always unwise to patent all the details connected with the process or all the features of the apparatus required for its operation.

In Germany very few patents, relatively speaking, are applied for, protection being had through secrecy. In this country patents are obtained with a freedom almost unbelievable; in fact, the habit of patenting inconsequential ideas achieves with many people almost the dignity of an incurable disease. The more reasonable course, I think, is to combine patents with secrecy. When the inventor approaches the fourth stage in the development of his process, and attempts to interest others in his scheme, he will find that the average business man places a higher value upon the intimate knowledge of the process which the inventor has acquired than upon the patent which is supposed to protect it.

It is important, therefore, that this knowledge be conserved, and to this end the management of the first four stages in the development of the process, from inception to and including the Semi-Commercial Plant, should be exclusively in the hands of the inventor and his immediate loyal assistants, as by no other means can the details of the operation be effectively controlled. If this is done the inventor will, upon the completion of the Semi-Commercial Plant, be in a position to ask and obtain excellent terms, not only for his patented process as such, but also for the exclusive knowledge which he and his immediate assistants have obtained through a long period of effort.

It will appear to many from what I have said that I am ultraconservative, and that the development of the ordinary chemical process might be conducted along more expeditious lines. I have not found this to be true, and, moreover, this opinion is shared by others. I could point out many cases where these rules

are followed in their essentials by successful inventors and investigators. It is true that in the early stages conservatism plays but a small part in the work. In fact, it is the mind that dares to think along unusual lines, the brain that does not work in channels, which conceives new processes, just as it is the explorer who dares to travel unchartered ways who brings back knowledge of unknown regions beyond. But as a process nears completion a man should become more and more conservative.

The great question as to whether development work pays can never be definitely decided. It all depends upon the point of view. Of the great army of prospectors who examine the vast areas around a newly developed mining camp, the number who "strike it rich" are so few as to be almost negligible, yet they all have had the thrills of anticipation, even if they have been a little short of the daily wage. Nearly all of the great explorers—Columbus, Hudson, DeGama, and the rest—died poor men. Peary, the greatest explorer of today, has few tangible assets to show for his twenty years' work in the Arctic. In the industrial field, Carnegie spoke with authority when he said, "Pioneering does not pay," and the fact that almost every business man of experience shuns any proposition that has experimental features connected with it, proves conclusively that the odds are greatly against success in development.

It may be justly concluded, therefore, that from the money standpoint exploration work as a rule does not pay; but, speaking broadly, it pays in other ways, and pays handsomely. I doubt very much if Peary would exchange the memories of the sensations he experienced when he realized that he stood at the "top of the world" for all the gold in the Bank of England. There is good reason to believe, too, that Hall, the modest inventor of the aluminum process which bears his name, never derived half as much satisfaction from any of the dividends he has since received (and they have been very large) as came to him with the glitter of the first bit of aluminum produced in his student days. Such rewards as these are beyond the power of the mint to coin.

It is a far cry from the beaker stage in a process to commercial success. The road is hard and rocky. The material rewards are few, but the view all along the way is bright with expectations; for the really great prizes are open to all. I have not attempted to describe this road in its full variety. It would require the super-assurance of a Rough Rider to undertake so difficult a task. Rather, I have tried to point out what appear to me to be the more important landmarks on the main highway, in the hope that by so doing others more experienced and competent than I will be stimulated to present their views.

The Commercial Synthesis of Ammonia, as a Process for Fixing Atmospheric Nitrogen

The direct production of ammonia from nitrogen and hydrogen was noted in ENGINEERING NEWS, June 23, 1910, as developed, on a laboratory scale, by Profs. Fritz Haber and R. Rossignol, of the Karlsruhe Institute of Technology. In a lecture, on Sept. 11, before the International Congress of Applied Chemistry in New York City, H. A. Bernthsen, of Germany, described the work of the Badische Anilin- & Soda-Fabrik in developing the work of Haber and Le Rossignol into a commercial process. He announced that the first factory for production of synthetic ammonia was being built at Oppau, near Ludwigshafen-on-Rhine.

Various investigations have shown that there was a certain equilibrium percentage of ammonia in a mixture of nitrogen and hydrogen gases under different conditions of temperature and pressure, and in the presence of certain contact catalyzing agents such as pure iron, nickel, manganese, etc. For a long time, however, it was believed that even with high temperatures or high pressures the equilibrium percentages were so small that the direct combination of nitrogen and ammonia was only a dream.

However, Prof. Haber believed that a technical synthesis of ammonia could be made commercially possible and he secured the assistance of the Badische Anilin- & Soda-Fabrik for the promotion of the work. His first advance was to show that the technical synthesis could be carried out, in spite of the unfavorable equilibrium percentage and the low catalytic capacity of the contact metals available, if the mixture of nitrogen and hydrogen was kept under constant pressure during the whole of the operation and subjected alternately to the catalytic formation of ammonia at high temperature and the absorption and condensation of the product at a low temperature. The nitrogen-hydrogen gas mixture was circulated under continuous pressure through the vessel for the formation of ammonia, the vessel for separation of ammonia and the circulating pump, all connected in a closed circuit but with a means of replacing as much of the gas as was converted into ammonia. The second important advance was the discovery that the advantages of heat regeneration in this process were no longer of vital importance, but that it was sufficient to work continuously under pressure. Finally it was found that if the reaction was carried out under very high pressures such as about 100 atmospheres or 150 to 200 atmospheres, it was not even necessary to circulate the gases continuously under pressure. It was possible to obtain 250 grams of ammonia per liter of contact space per hour under a pressure of 200 atmospheres and with a temperature of 650° to 700° C., using iron catalyst, prepared from purest iron oxide and occupying a space of 20 c.c., and with a gas speed of 250 liters per hour (measured at ordinary pressure).

A further great step was taken when Prof. Haber found catalysts with a property of rapidly combining nitrogen and hydrogen to give sufficient percentages even at much lower temperatures than those previously used. Uranium proved a good agent; it could be employed in the form of metal, an alloy, a nitride, or a carbide. It was possible to secure an equilibrium percentage of 10.8 under 100 atmospheres pressure and 500° temperature.

The commercial development of the process was taken up in 1908 by Dr. Carl Bosch, of the Badische company. The new and difficult problem to be solved was that of constructing commercial apparatus for working with compressed gases under high pressure and elevated temperatures not far from red heat. Moreover, the metals which came into consideration for apparatus construction, and especially iron, were chemically attacked above certain temperatures by the gas mixture under pressure. The various construction difficulties, it was stated, however, had been completely overcome. It was intimated that there was still danger of explosion or burst of flame if the apparatus should happen to become defective, and this was to be guarded against by setting it up in bomb-proof chambers.

Great care had to be taken that oxygen or air did not get into the apparatus or the piping, for, at the high pressures obtained, the explosive range is reached with a very slight percentage of oxygen. Special devices are installed to sound an alarm immediately a definite percentage is reached. The proper constitution of the gas mixture in circulation is controlled by analysis from time to time. The ammonia can be removed from the apparatus as a liquid or by directly introducing an absorption agent such as water. Under the pressure used, a concentrated solution is easily secured.

The company pursued investigations into the action of the various catalyzers. It was found that, in general, these active bodies were made more active by the presence of certain foreign materials, and this has proved to be of prime importance. Among the "promoters" are oxides, hydroxides, or salts of the alkaline earths and the earth metals. In many cases a minute quantity suffices to raise the activity. The action of these foreign bodies is especially powerful under certain conditions; for instance, when the metals or oxides or carbonates are converted into oxides on heating, if they are first heated to high temperatures,

preferably to the melting point so that the resulting product consists chiefly of oxides. This marked increase of activity is considered to be due to the dissolving of the additions in the highly heated metallic oxides, or becoming finally divided in it so that in the following reduction a sort of skeleton is formed inside the metallic mass to prevent a diminution of the surface.

Good results were secured with pure iron at a temperature not much above 600° C. so long as the iron intended for the agent was prepared from the oxide at a temperature not above 600° C. Manganese gave good results, provided care were taken to completely free the mixture of nitrogen and hydrogen from oxygen and moisture. Molybdenum, another member of the iron group, proved excellent and, under some conditions, so did tungsten either as a metal, as an alloy or as a nitrogen compound.

Another important discovery for the industrial application of the process was the recognition of special "poisons" for the catalyzing agent. These were metalloids like sulphur, solenium, tellurium, phosphorus, arsenic, boron and compounds of these elements, or sulphuretted hydrogen and many such compounds, or certain metals of low melting points like lead, bismuth and tin, which could be readily reduced by hydrogen from their compounds. Even minute quantities of these were sufficient to render the catalysts absolutely inactive or seriously to diminish their action. Therefore, it is necessary to prepare the contact masses free from "poisons" and to free the gases to be acted on from all such. One good method found of removing impurity from the gas mixture was to bring the gases into contact with similar contact-mass material before passing over the actual catalyzer. The first material then takes up the impurities and must be renewed from time to time.

It had not been difficult to obtain the necessary nitrogen from the air by physical means such as Linde's process or chemically through removing the oxygen by glowing copper, burning hydrogen, etc. The needed hydrogen can be secured as the byproduct of the electrolysis of common salt, by passing steam over hot iron or from water gas by cooling to very low temperatures. Both elements are at the disposal of the new industry to any extent and sufficiently cheap. The production of these elements is not confined to the locality of cheap water power, so that all countries are in a position to profit by this new industry.

Nitrates from Air—A plant for producing nitrates from air and combustible gas by direct combustion, whereby the nitrogen of the air burns to nitric oxide, which after absorption in water yields nitric acid, is being built at the De[illegible]del coal mine near Hamm, Westphalia, Germany. The plant is based on experiments made by F. Häusser, of Nuremberg, reported in "Zeitschrift des Vereines deutscher Ingenieure," of July 20, 1912.

In these experiments both illuminating gas and carbon monoxide were used. The gas mixed with air was led into a combustion chamber whose inner surface was coated with white enamel and was ignited by a high-tension spark. Water was injected into this chamber a small fraction of a second after the ignition, the length of time being fixed by a falling weight, which in its upper part made the ignition contact and at the end of its fall opened the water valves. The water injection had the object of producing a very rapid cooling of the temperature within the chamber between the ranges of about 1600 and 800° C., to minimize the loss of nitric oxide by dissociation. Using carbon monoxide, a nitric acid yield of 75 grams per cubic meter of gas was obtained. With illuminating gas a yield of 99.5 grams nitric acid per cubic meter was found. These values are considerably above the computed values based on thermal equilibrium, which is explained by assuming that there is a certain amount of photochemical action. Two combustion chambers of different sizes being compared, the larger combustion chamber gave better yield. The small laboratory apparatus used enabled a nitric oxide content of 0.8% to be obtained, and it is expected that on a commercial scale much higher concentrations of nitric oxide can be produced.

Letters to the Editor

Electrolysis of Plain Concrete

Sir—In reference to the editorial comments in your issue of Sept. 19, on the withdrawal of my paper on "Electrolytic Action on Unreinforced Concrete," from the recent meeting of the International Association for Testing Materials, permit me to say that the reason for the act was that, owing to my position, it might be inferred that my conclusions related to the Interborough Rapid Transit subway structure—an inference which is wrong. The present subway is practically watertight, and therefore is not subject to the conditions that may prevail elsewhere. I have found, in making some changes which have necessitated cutting out some concrete, that this appeared harder than normal, something which would seem to bear out a test made by a well known chemist who has been making experiments with dry concrete for some time. If all concrete structures were built and maintained with the same care as the present subway there would be no cause for worry.

CYRIL DE WYRALL.

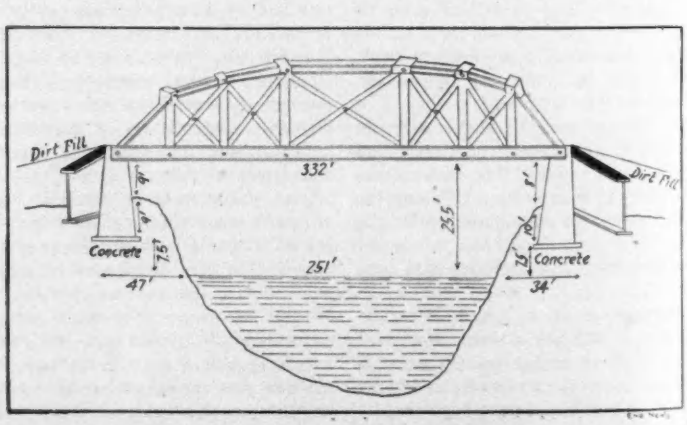
New York City, Sept. 23, 1912.

Design for an Arkansas County Bridge

Sir—The bridge design(?) shown in the accompanying illustration was placed before prospective bidders at a recent bridge letting. Presumably the county officials expected to let a contract for building this bridge, as shown, without further information. The design is the work of one who signs his name over the title "Civil Engineer."

ELMO G. HARRIS.

University of Missouri,
School of Mines and Metallurgy,
Rolla, Mo., Sept. 13, 1912.



DESIGN FOR AN ARKANSAS COUNTY BRIDGE
(A "Civil Engineer's" design for a County Bridge.)

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Engineering News

The U. S. postal laws have been so construed in recent years as to deny to engineering societies the second-class postage rate in mailing their published proceedings to their members, unless the members paid a subscription price separate from the annual dues. A good deal of trouble and annoyance has been experienced by several of the engineering societies during the past three years through an attempt to enforce this law to the letter.

In the post-office appropriation bill recently enacted, however, a clause has been inserted putting an end to this long standing difficulty. Hereafter the publications of societies, institutions of learning, state boards of health and state boards of charities and correction are entitled to the second-class mail rate, provided they are issued regularly at least four times a year and are not published primarily for advertising purposes, and provided the members receiving such copies pay at least half the regular subscription price, either as a part of their regular dues or otherwise.

An Early View of the Steamboat

Not long after Robert Fulton successfully operated his first steamboat on the Hudson River, Henry Bell, of Scotland, began running his famous "Cornet" on the River Clyde.* The centenary of that pioneer Scotch vessel, just celebrated, has brought out hidden records of those early days in steam navigation, but no more interesting one than that which we reprint below, showing a contemporary comment. The paragraphs appear in London *Engineering* of Sept. 6, and is credited to the Glasgow *Herald*, as from the annals of a Scottish minister:

In a village, adjacent to That City, the Smoke of whose Abominations goeth up to Heaven as a thick cloud, and of whose wickedness ourself was witness in our days at College there, in Helensburgh to wit, there dwelt a man of skill in the art of the Engineer. He being puffed up in pride of his Abilities therein, did lately Conceive a Ship to go upon the waters, not by dint of the Clean winds of the Air, as ordained of God, but by means of fire which burned and a great Smoke which issued from the bowels thereof.

In this Device the Man did sail upon the River Clyde in Pride and highness of Heart to the Great scandal of pious minds; but also to the Huge Gratification of the Man and those that were with him. But not Content to keep his Unholy devices in the scene of their Conception, this Man must needs sail or propel his Creature even unto Crinan itself, near to which place your Servant labours in the Gospel both in The Gaelic and English. And so to Fort William, with much effusion of stinking vapour and great hurt to the light-minded of this Congregation, and of the Christian Consciences of the People of Argyll, The Isles, and even Inverness.

*For a history of Fulton and the other pioneer inventors of the steamboat, see Eng. News, Sept. 16, 1909; Feb. 24, 1910.

The Lesson of the Austin Dam

We believe there are few engineers among the readers of this journal who will not find it well worth while to read the paper in this issue of ENGINEERING NEWS on the failure of the Austin Dam, written by T. Chalkley Hatton, the engineer of that structure. It is not Mr. Hatton's statement of the causes of the failure that is of importance. Those causes were correctly set forth in the issue of ENGINEERING NEWS immediately following the failure, and have been thoroughly discussed in engineering literature since that time. The impressive lesson to the profession in Mr. Hatton's paper is not in its technical features but in what it suggests as to the attitude of mind in which the engineer who is charged with heavy responsibility should approach his work.

It is entirely natural, probably, for the average engineer when he hears of an accident to a structure to say to himself and perhaps to others, "Well, that wouldn't have happened if I had built it." We are all of us a little too prone, perhaps, to assume that we ourselves could not have been guilty of the particular piece of carelessness or blundering or oversight which brought about disaster. In the case of the Austin Dam, for example, we believe a large proportion of the profession have the idea well established in their minds that the construction of the dam was seriously defective in half a dozen different ways, and that its failure was what would naturally be expected.

To those who consciously or unconsciously have entertained such a view, we recommend a careful reading of Mr. Hatton's paper. It will be evident to the engineer who gives it a careful reading that Mr. Hatton *did* take conscientious care in the design and construction of this dam. He had, it is true, to economize in cost to meet the conditions imposed by his clients, but that is true of 95%, if not 99%, of all engineering work. He did introduce provisions for additional safety and strength which his clients thought at the time were needless

refinements. There can be no doubt that Mr. Hatton fully believed at the time that he had made sufficient provision for safety in every part of the design and construction. He is an engineer of long experience and good reputation for conservatism.

It is especially noteworthy that Mr. Hatton had drill holes put down in the rock before laying the foundation of the Austin dam to test the permeability of the underlying strata and found no water entering them. This is an example of the care that was used by the engineer to make certain of the stability of the structure.

It seems to us that this plain statement of Mr. Hatton's as to the precautions he took, makes the lesson of the Austin Dam tenfold more impressive to the engineering profession. We may not lightly dismiss it as another example of the results of engineering carelessness. Instead, it should be an impressive lesson of the need of the greatest care in every detail of engineering work to guard against disaster.

There is another aspect from which Mr. Hatton's paper is most important. How rare is it when the engineer of a structure which has failed is brave enough to tell the whole story to his fellow members of the profession and manfully assume the responsibility. No one can read Mr. Hatton's frank, manly confession that he made a mistake without profound respect and a realization that he shows true professional spirit. And what was the mistake? It was in trusting entirely to his own judgment with respect to the foundations of the structure and omitting to ask the aid of a consulting engineer as to whether the precautions he had taken with regard to the foundations were sufficient.

But if this is to be regarded as a mistake, it is one which is made in hundreds if not thousands of cases every year. It is indeed the rare exception rather than the rule when an engineer has the bravery to say to those who employ him, "I would like to have the advice and approval of an engineer of larger experience than myself before deciding upon this piece of work. Will you stand the expense of obtaining an opinion from a consulting engineer upon this?"

We say it requires bravery to take this position because the public, unfortunately, expects an engineer to know everything. There is always a tendency when a man says that he must have the advice of another engineer in order to decide upon a piece of work, for the economical city councilman or member of the Board of Directors to say, "Well, we ought to have employed an engineer in the first place who was competent to decide these things for himself." It is for this reason that we say it takes real bravery for the average engineer in a responsible position to say to his clients or employer that he would like to have his own judgment confirmed by that of some member of the profession of larger experience.

While the lessons in Mr. Hatton's paper come home with force to engineers engaged in all classes of work, they appeal with especial emphasis to the builder of dams. A few months ago, in commenting on the phenomenal number of dam failures, we referred to the popular impression that a dam is such a simple sort of a structure that almost any engineer or near-engineer or no-engineer can built it perfectly well. There is, perhaps, something of that feeling that a dam is an easy thing to build in the engineering profession itself.

The records of the numerous dam failures which have appeared in the columns of ENGINEERING NEWS during the past ten years can serve no purpose more useful than to convince all engineers that any structure built to retain water demands the greatest care and skill in its design and construction if safety is to be secured. We do not mean by this that it is not possible for competent engineers to build dams which will be as safe as any structure whatever that is built by man. The experience of the past dozen years, however, has abundantly determined that particular care ought to be taken with the foundations on which a dam rests. Most dams which have failed have failed not by leakage through the dam itself but through the material underneath them. It behooves the responsible engineer of any such structure to make assurances doubly sure that conditions are right there before he proceeds to build the structure itself.

A few years ago, in commenting on the lessons of the monumental disaster at Quebec, when the great cantilever bridge under construction across the St. Lawrence fell in a terrible wreck, we remarked that the great lesson after all of the Quebec Bridge disaster was the lesson of humility. The same impression comes to us, and we hope will come to our readers, as they study Mr. Hatton's paper in this issue.

All of us can well afford to extend a large measure of charity and sympathy to those of the profession whose work goes down in disaster. The error by which the disaster resulted may be one which we ourselves might have committed under similar circumstances. ENGINEERING NEWS has for many years been diligent in securing and publishing records of accidents and failures to engineering structures, but we have done this in no censorious spirit. All of us are prone to err; all of us need to learn all we can from the mistakes of others, as well as from our own. It is lessons of this sort that Mr. Hatton's paper teaches to the engineering profession.

Developments in the Chicago Subway Scheme

The congestion of street traffic and local transportation facilities in the business districts of large cities usually leads to the suggestion of subway systems to improve the facilities for local transportation and also to afford better conditions of rapid transit throughout the city. In Chicago this subway matter has been put forward intermittently during the past twenty years, and it seems now to be approaching the termination of the promotion stage, preliminary to the construction stage. It will be of interest, therefore, to review the history of the subway projects and to explain the present situation.

As long ago as 1900 the street railway companies proposed to the city the construction of a series of underground terminal loops to relieve the traffic congestion of the downtown district. Since that time numerous projects have been put forward, some by private parties and others by engineers and commissions appointed by the city, and a list of these projects is published elsewhere, in connection with an abstract of a recent report by the city's Harbor and Subway Commission.

We are not at present concerned with these earlier stages of development except to note the important feature that in nearly every project proposed the fundamental principle was to relieve traffic congestion in the downtown district, with increase in rapid-transit facilities for outlying districts as a secondary matter. This being the case, the radiating lines of the subways were relatively short, their limits being in general at about Chicago Ave. on the north, Halsted St. on the west, and 12th St. on the south; each of these streets is about a mile from the center of the business district. These conditions of traffic and these boundary limits were governing factors in the reports made by Mr. Ericson (City Engineer) in 1909, and by Mr. Arnold (Chief Engineer of the Board of Supervising Engineers) in 1911.

But in view of the great number of surface lines which converge at the business district it would be very difficult to combine many of these in the subway routes without exceeding the capacity of the subways, and thus eliminating the desirable and much needed advantage of high speed. Many plans have been proposed to obviate this difficulty, mainly by multiplying the subways in the congested district and providing both through routes and concentric terminal loops. The construction cost would be high, however, and the operation of such systems would be so complicated that it would be a difficult matter for a passenger to know where and how to get a car for any particular route. In any case, the subway systems of this class (that is, accommo-

dating the cars of existing surface and elevated lines) would probably have their capacity reached, if not exceeded, as soon as put in operation. Further, they would provide only a limited relief to the traffic congestion in the streets and only limited improvement of rapid transit facilities for serving outlying districts, while they would provide few, if any, additional facilities for the future growth of traffic. In view of these conditions some of the later projects have provided separate subway systems for the surface and elevated lines.

Coming now to the explanation of the present status of the problem, it may be stated that during the summer of 1911 the Council committee on local transportation held a series of public hearings, at which a number of subway schemes were presented. Following this, the mayor appointed (in July) a Subway Commission composed of three engineers (Messrs. Ericson, Shankland and Reynolds) to prepare definite plans for a subway system to accommodate the cars of surface and elevated railways. In October, this commission made a report presenting plans for separate subway systems for the two classes of traffic, and still keeping practically within the boundary limits already mentioned. This report contained one specially important feature, in stating that the Commission questioned the wisdom of providing subways for surface car lines, although it had planned these according to instructions.

In all the city's work of subway planning subsequent to 1907, the surface railways had coöperated, and it was assumed that these lines would use the subways under the relations established between the city and the companies by the ordinance of 1907, which closed a long period of controversy. One of the important provisions of this ordinance is that the companies are required to pay to the city 55% of the net receipts (after the deduction from the gross receipts of the operating expenses and 5% interest on the capital investment).

At this stage the elevated railways entered as a new factor. Following the subway report of October, 1911, a movement was made by financial interests to establish relations between the elevated railway companies and the city. These companies were consolidated in July, 1911, but the lines continued (and still continue) to be operated as separate properties, with no transfers and no through routes; thus the trains of each line enter and leave the business district over the same line, and a passenger making a journey involving two lines must pay two fares. This system of operation, by which every train is passed around the four sides of the terminal loop, is one of the important causes of slow service and traffic congestion on the elevated railways.

DEVELOPMENT OF RAPID TRANSIT TRAFFIC IN NEW YORK, SHOWING THE RELATION OF THE SUBWAYS TO OTHER LINES

Year	Traffic (in millions) Surface lines	Elevated lines	Subway lines	Total	Increase over preceding year Millions	P.ct.
1904	680.5	383.6	.....	1064	65.0	6.5
1905	680.6	375.5	72.7	1129	64.6	6.0
1906	730.4	383.0	147.9	1251	22.4	1.9
1907	720.0	429.1	166.3	1315	64.2	5.1
1908	716.4	435.9	200.4	1353	37.3	2.8
1909	722.1	427.4	238.4	1388	35.1	2.6
1910	760.3	459.5	268.9	1489	100.9	7.3
1911	802.8	472.9	276.7	1551	62.6	4.2

The financial interests which had effected this consolidation proposed to go still further and consolidate the elevated and surface railways into one concern, provided that suitable terms and franchise relations could be agreed upon with the city. The consideration of such a proposition necessarily involved the valuation of the elevated railway properties, and Mayor Harrison appointed the members of the Subway Commission (with George Weston in addition) as a special committee on valuation to represent the city. The elevated railways appointed Prof. Swain, of Harvard University, as their representative. We may note that this valuation had to deal only with the physical property, the value of franchises being left for consideration by the City Council and its committee on local transportation.

We need not discuss here the details of the investigation, but it will suffice to state that fundamental differences of opinion arose between the representatives of the city and the companies, and that being unable to secure an acceptance of his views the companies' representative finally withdrew from the conferences and made an independent report. The two reports showed an astonishing difference in the valuations. The city figures were approximately $62,000,000 for the cost of reproducing the property new, and $53,000,000 for the present or depreciated value. The company's figures were approximately $98,000,000 and $93,000,000, or 60% and 75% higher. The greatest difference was in the real estate, which was valued at $16,250,000 by the city and $46,780,000 by the companies.

After some controversy and entire failure to arrive at any modification of the figures, a new valuation by a new joint committee was requested by the companies, but with the condition that no member of the former committee should be included. The mayor declined to accede to this condition, and the companies then announced that they would withdraw from the negotiations. This action (in May, 1912) left the city free to proceed along its own lines, and it may be noted that nothing further has been heard of a consolidation of all the Chicago traction interests (surface and elevated).

In the meantime, the Subway Commission had taken another very important step. In February, 1912, it presented a report stating that there was urgent necessity for immediate subway construction (whatever the result of the negotiations with the elevated railway companies), and outlining a proposed system of subways that would be entirely independent of all existing transportation systems, and would cover the city as a whole. In other words, it departed from the former principle of providing subway terminal facilities for the existing surface and elevated lines, and started out on the principle of providing a new and independent rapid-transit system for the entire city. The report was supplemented and somewhat modified by the report of September, 1912. This latter report is dealt with elsewhere in this issue, in an article which describes the proposed routes and outlines the main factors of design, equipment, financing and operation.

In brief, the scheme provides for a municipally owned and controlled rapid-transit subway system, the construction to be financed by the city or by private capital, and the operation to be leased to an operating company. The system comprises about 56 miles of line, with an estimated cost of $96,000,000 for construction and $35,000,000 for equipment (or a total of $131,000,000). It provides a capacity of about 180,000 seats per hour.

The matter now awaits action on the proposed routes by the City Council when it resumes its meetings. If these are adopted, work can be commenced at once upon definite plans and specifications, but until such official action is taken nothing further can be done.

The foregoing review covers the history of the Chicago subway scheme up to the present time. No detailed estimates have been made of traffic, revenue or operating costs for the proposed system. But on the basis of results at New York, with due allowance for difference in conditions, it is considered that financial success is practically assured. For one thing, the city of Chicago is considered to be in a position to make much more favorable terms with an operating company.

As to cost of operation in New York, the operating expenses (including taxes) of the subway division of the Interborough Rapid Transit Co. were 35.75% of gross earnings in 1910, and while they rose to 43.18% in 1911, the company's report states that this increase was due largely to extraordinary expenditures (approximately $700,000) resulting from changes in equipment, made necessary in connection with the operation of ten-car express trains and six-car local trains. It is to be remembered also, that the per capita traffic in Chicago is increasing very rapidly; from 200 in 1900 (with 1,700,000 population) it rose to 300 in 1910 (with 2,200,000 population). These figures are for local transportation only,

and exclusive of suburban traffic on steam or electric railways.

Further, the subway system will not depend upon traffic taken from other systems of transportation, since experience indicates that the provision of new facilities develops new travel. This is almost universal experience and is illustrated forcibly by the conditions in New York, shown by the figures of the accompanying table. These are condensed from a report of a committee of the Board of Estimate and Apportionment and are exclusive of the Hudson & Manhattan subway lines.

The average rate of increase of rapid-transit traffic in New York has been 5½% per year, and the subway traffic has increased 280% between 1905 (its first year) and 1911.

The need of improved facilities in Chicago is evident and urgent. In fact, the congestion of traffic in the business district is so great during several hours of the day that the service can hardly be called rapid transit. Mr. Ericson has stated that the average speed on the elevated railways (but outside of the loop district, where most of the traffic starts and terminates, and where the speed is very slow) is only 17 to 18 m.p.h., while in the New York subways it is between 25 and 26 m.p.h. The need of increased carrying capacity for the transportation systems is abundantly evident. The next step is the adoption of some definite scheme by the city, and such a scheme is now ready for its consideration. Coincident with this must be a decision uon the system of financing, as explained elsewhere. The engineers have carried their work as far as possible in advance of the adoption and financing of a definite system of subways, and the matter now awaits the action of the city authorities.

Heat Transmission through Building Walls of Corrugated Iron*

Some time ago it was found advisable to make service tests on a hot-blast heater outfit installed in the new fan shop of the Green Fuel Economizer Co., at Matteawan, N. Y. Advantage was taken of that opportunity to determine the rate of heat transmission through the walls of the building itself, the walls and roof consisting solely of glass and corrugated iron as may be seen from the accompanying figures. The second test was desired for, when the building was erected, there was some little difficulty in finding authentic information on the rate of heat transmission through corrugated iron. In fact the company was prepared, if necessary, to line the building so as to maintain a comfortable temperature with a moderate expenditure for heat.

To the surprise of the engineers (in spite of a theoretical analysis which agreed in general with the results of the test) the heat loss was not excessive. This was due in part to the care taken during construction to prevent air leaks, the crevices under the eaves being plugged with asbestos and the bottom sheathing being cemented into the floor.

The shop measures 225x48 ft., with an average height of 32 ft., as seen from Fig. 1. There are continuous windows on one side 15 ft. high and on the other side 19 ft. high. Except for such openings and the doors, the building is covered with a single thickness of corrugated iron without lining. The window exposure is east and west, the smaller openings being on the east side.

In planning for the heating of this building, the coefficients for the rate of heat transmission through single windows were found to vary somewhat. Prof. Homer Woodbridge gave for single windows with a southern exposure, a coefficient of 1 B.t.u. per sq.ft. per hr. per degree difference in temperature between inside and outside. For northern exposure he suggested adding 35%, for eastern exposure 15, and for western exposure 25%. Ludwig Dietz, quoting Dr. Rietschel, of Berlin, and also the specifications of the Prussian government, gave for single windows 1026, and Dr. Rietschel suggested increasing this 10% for northern, northeasterly, or northwesterly exposures, and 10% for especially strong winds.

The only corresponding figure for corrugated iron without sheathing that was found is also one by Rietschel of 2132, but without any statement as to whether this refers to superficial wall area or to the actual surface of the iron. The designers were therefore led to develop a value from theoretical considerations.

It was seen that the formula for the coefficient of transmission usually employed has the form

$$K = \frac{1}{\frac{1}{A_i} + \frac{1}{A_o} + \frac{x}{e}}$$

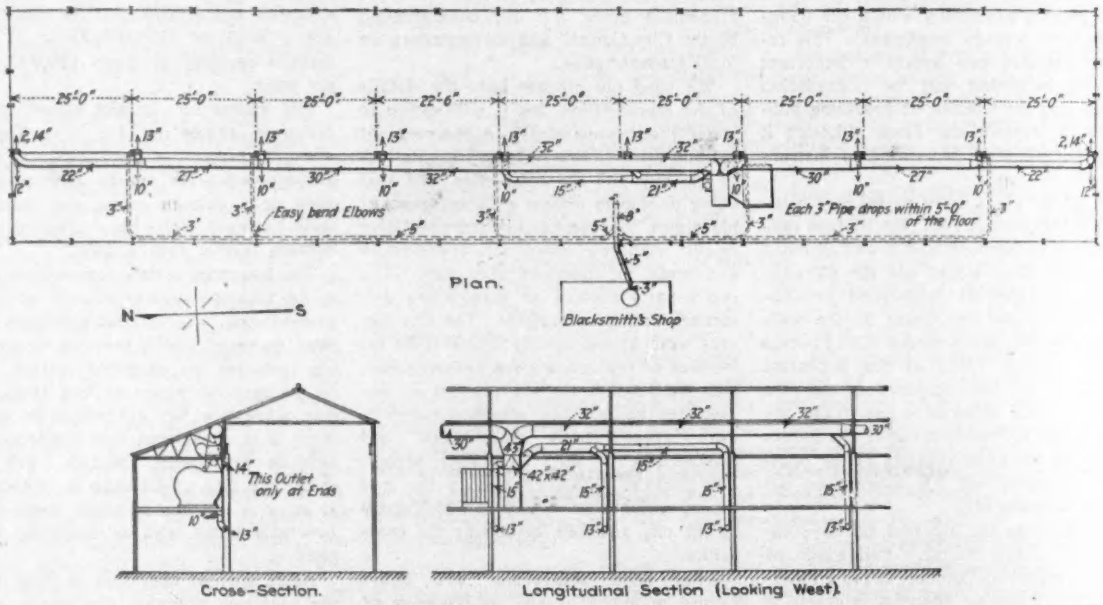

FIG. 1. PLAN AND SECTIONS OF NEW FAN BUILDING, GREEN FUEL ECONOMIZER CO.

*From information furnished by A. H. Blackburn, General Manager of the Green Fuel Economizer Co., Matteawan, N. Y.

where A_i is the B.t.u. transfer from inside fluid to wall, A_o is the transfer from outside wall to exterior fluid, and e is the conductivity of the wall material, expressed in British thermal units per square foot per hour per degree of temperature drop per inch of thickness, and x is thickness in inches.

For the value of A_i and A_o, Grashof gave the expression

$$A = c + d + \frac{(40c + 30d)}{10{,}000} T$$

in which c depends on velocity of the fluid. Rietschel gave for air at rest $c = 0.82$, for slow motion as in contact with cold windows $c = 1.03$, and for rapid motion as outside of buildings $c = 1.23$. He gave for glass $d = 0.60$, and for sheet iron $d = 0.57$. T for single windows was 36 and no value was shown for iron; but it probably was of the order of the figure for glass.

Calculating from the preceding, it was found for a single glass window that $A_i = 1.84$ and $A_o = 2.07$; for sheet iron $A_i = 1.81$ and $A_o = 2.04$. For e, Rietschel gave 190 for iron and 6.6 for glass. It was evident that the term $\frac{x}{e}$ was here negligible for both iron and glass—similar to cases of higher temperature transfer in boilers, heaters, condensers, etc. For a single window the coefficient K, worked out as 0.958 and for a single thickness of sheet iron as 0.955. The results from using Grashof's formula were seen to be lower than the values of ordinary practice. This was explained by noting that the constants in common use have an increased value to account for losses due to leakage, to opening and shutting doors, etc. Weight was also given to this view by the results of the test, with air leakage reduced to a minimum. Close agreement was not expected on account of various complications; the metal-working machinery and shafting were in constant operation during the test and liberated heat which was not measured, while, on the other hand, doors were opened about once every ten minutes for the passage of men and materials.

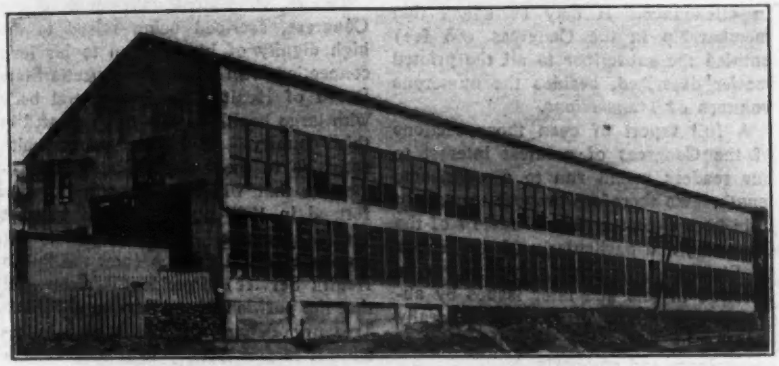

FIG. 2. EXTERIOR OF CORRUGATED-IRON FAN SHOP, MATTEAWAN, N. Y.

The total surface of the building is made up of approximately 7538 sq.ft. of window, including the sash; 8247 sq.ft. of wall surface and 11,925 sq.ft. of roof, the walls and the roof being given in superficial area. The total of wall and roof areas is 20,172, which, increased by the factor 1.35, to account for the corrugations, gives 27,130 sq.ft. actual metal surface. The total superficial expanse of the building is 27,710 sq.ft., and the total actual surface, counting the metal in the corrugations, is 34,658 sq.ft.

The building is heated by a hot-blast system, in which an engine-driven centrifugal fan draws air over six 7x8-ft. sections, each of four rows of pipe. The heater is ordinarily drained of condensate by a vacuum system. There is in all 6816 ft. of 1-in. pipe in the outfit or 2272 sq.ft. of heating surface. The heated air is distributed about the shop by circular iron conduits with outlets directed down into the zone occupied by the workmen, as shown in Fig. 1.

The fan and heater had been running for about two hours when the first readings were taken at 8:30 a.m., and the temperature of the shop was maintained constant until readings were discontinued, at 11:30 a.m. During the test the fan was run at 258 r.p.m., receiving 22,416 cu.ft. of air per minute (figured for 50° F.) the air actually being received by the heater at 73° and delivered from the fan at 156°. The temperature of the steam in the heater was 212°. The temperature of the air delivered from the farthest outlet was found to be 1415 F. Under these conditions, the temperature of the building measured 3 ft. from the floor, was 66°, and measured in the gallery, 70°, the temperature out of doors being 15°.

For the determination of the total heat, two methods were employed. First it was calculated from the amount and rise in the temperature of the air passed through the heater, and secondly, from the condensation in the heater. For the latter purpose, the steam pipe from which the steam was introduced to the heater was carefully drained and the condensate from the heater was weighed. Figured by the air method, the consumption of heat was 2,084,000 B.t.u. per hour, and by the condensate method, 2,029,730.

Using the air figures, it was found that the average rate of heat transmission through the superficial area of the building (that is, not counting the corrugations) was 1.42 B.t.u. per sq.ft. per hour per degree difference, and using the steam value, 1.38 B.t.u.

It was found, taking Prof. Woodbridge's figures, before given, there resulted for a window with an average of the shop's exposure, 1.2 B.t.u. per sq.ft. per hour per degree. This would leave for the corrugated iron only 1.5 B.t.u. figuring on superficial area, and 1.13 using actual iron surface. The latter figure is somewhat less than an equivalent amount of glass surface. At first this seems rather improbable, but it may be explained from the fact that the loss per unit actual area of corrugated surface is less than from the same area of a plane. Conduction and convection loss depends on actual exposed area, but the true radiation component depends on the superficial or projected area and is the same for a given rectangle whether filled with a plane sheet or a corrugated one.

When the value for glass was taken from Grashof's method (0.958), the value for actual iron came out at 1.19. But on the basis of that formula there is no reason to expect such a difference. Allowing for the many undeterminable conditions, and the fact that only one test was seen, it would seem safe for engineers to use a coefficient of 2 B.t.u. for wall and roof areas of such a building as herein described.

An interesting point was noted in testing the hot-blast heater. The coefficient of transmission through the surface of the heater in this test was 9.41 B.t.u. per sq.ft. per hour per degree average difference in temperature between the air and the steam, figured by the ordinary arithmetical method in which the average difference in temperature between the steam and the air is assumed to be the difference between the steam temperature and the mean of the air temperature on entering and leaving. Figured according to the logarithmic formula, which takes account of the fact that the air rises more rapidly in temperature in passing over the first rows of tubes than in passing over the later rows of tubes, the value was 10. The mean velocity of the air through the heater was 1210 ft. per min.

In a subsequent test, with air entering at 72° F. and leaving at 166° F. and steam at 313°, in which the velocity of the air was 760 ft. per min. a coefficient of transmission of 7.5 (logarithmic) was obtained. But 10 and 7.5 are in the ratio of the 0.64 powers of the respective velocities; that is, the coefficient did not vary directly as the velocity, as often assumed. When, instead of mean ve-

locity, were used flows in pounds of air per minute through the heater, which amounts to the same thing as velocities reduced to a standard temperature, the coefficients were found to be in the ratio of the 0.62 powers of the rates of flow.

The International Congress on Hygiene and Demography

Many hundred scientists and public-health administrators from all parts of the world gathered at Washington, D. C., Sept. 23 to 28, to attend the Fifteenth International Congress on Hygiene and Demography. The Congress was organized in nine sections and two subsections, as follows:

I. Hygienic Microbiology and Parasitology.
II. Dietic Hygiene; Hygienic Physiology.
III. Hygiene of Infancy and Childhood; School Hygiene.
IIIa. Subsection on Mental Hygiene.
IV. Hygiene of Occupations.
V. Control of Infectious Diseases.
VI. State and Municipal Hygiene.
VIa. Subsection on Sex Hygiene.
VII. Hygiene of Traffic and Transportation.
VIII. Military, Naval and Tropical (Colonial) Hygiene.
IX. Demography.

There were a few combinations of two sections and there were three or four plenary sessions, but as a rule (evenings excepted) each morning and afternoon saw a half dozen or more sections engaged in a desperate effort to get through their portions of the 40-page program, which was said to embrace no less than 450 papers.

The section names, already given, afford some evidence of the thorough way in which the whole field of the Congress was covered. The broad subjects assigned to the various sections were still further divided and subdivided. The authors were chosen with equal care, so that altogether no pains were spared to insure as comprehensive and at the same time as detailed a review of the public-health field of the world as was humanly possible in such a number of 20-minute papers as could be crowded into a week, and still leave room for social functions and a modicum of sightseeing.

As might be expected from such a program and of such a Congress the papers were reviews or summaries of present status rather than contributions of new matter. The papers dealing with a given specialty, therefore, were not so instructive to the workers in that field (unless, perhaps, of another country) as to the workers in other and more or less closely allied fields, who wished to extend their horizon. From this and from the social viewpoint was the Congress of greatest value. There were, of course, many papers of a highly technical character, whose appeal was to a limited class of specialists.

The one great lack of the Congress was time—both for the presentation and the discussion of the papers. The only way the program could be completed, at least in some of the sections, was to see that the authors of papers hurried through them in rapid succession, with no discussion until all the papers scheduled for the session had been presented. Then there might be twenty minutes' time to discuss a half dozen papers, perhaps on three or four different topics. Discussions were limited to five minutes. Under such a combination of circumstances it was not always the person best fitted to discuss the papers who occupied the little time available.

A goodly number of the papers were available in brief abstract when the convention opened. These abstracts alone made a volume of 297 pages. The abstracts were available in German and French, as well as in English. The program was also printed in three languages. A *Journal*, issued two or three times during the Congress, gave the names and the home and Washington addresses of those in attendance. It may be added that membership in the Congress ($5 fee) entitled the subscriber to all the printed matter described, besides the numerous volumes of *Transactions*.

A full report of even those sections of the Congress of greatest interest to our readers would run to a wearisome length. We therefore propose to attempt little here except a general review of the Congress, and particularly of the section on State and Municipal Hygiene, to be followed in this and later issues by abstracts of some of the papers, generally grouped by main topics for the sake of convenience and emphasis.

The Opening Session

The Congress opened on Monday morning, Sept. 23, in Memorial Continental Hall. The large main audience room was reserved for foreign delegates, thus relegating and elevating to the gallery all delegates from the United States.

The features of this session were addresses by the President of the United States, the President of the Congress, and official greetings, from representatives of twenty-eight foreign countries.

President Taft, clothed in a gray business suit, which was in marked contrast with the military regalia of the official representatives of a number of foreign countries, delivered a telling address on the national health activities of the United States. In the course of his remarks he said:

> We need to develop under governmental auspices a bureau or a department, in which the funds of the Government shall be expended for research of every kind useful in the practice and enforcement of hygiene and preventative medicine. That something of this sort may grow out of the present United States Public Health Service, there is reason to believe, but it will need far greater appropriations and a widening of its scope of duties before it shall have filled the place that the medical profession of this country has a right to expect the general Government to create in the progress of hygiene and demography.
> Our responsibilities in Cuba, Porto Rico, and the Philippines, and now of the Isthmus of Panama, have so enlarged our knowledge of the possibilities of successful sanitation under the most burdensome conditions, and have so impressed both professional men and the laymen at all familiar with the conditions, with the necessity for more rapid and comprehensive health laws, and a stricter enforcement of them for the general public good, that if the Spanish war resulted in nothing else, it was worth greatly more than its cost in this useful development of one of the most important functions that modern government has to discharge, as well as in making clear the need of an additional branch of general education in the matter of hygiene of the home and the individual.

Credit was given by the President to both engineers and physicians for their sanitary work at Panama. In closing, the President described the Congress which he was addressing as one of those world organizations for promoting the welfare and peace of the whole world. Believing that the Congress would give both inspiration and impetus to health-protective work in this country, he welcomed it to the United States and to Washington.

Dr. H. P. Walcott, President of the Congress, ascribed being raised to the high dignity of his position to his long connection with the Massachusetts State Board of Health, the first central body with large health powers to be created in this country. Reviewing public-health activities in the United States, he remarked that when the constitution was formed in 1787 public hygiene was not yet in existence. Coming down to the Marine Hospital Service (now the Public Health Service), President Walcott said that the position of the Service under the Treasury Department has tended to incline it to subservency to financial interests. The Owen bill, providing for a federal bureau of health, meets with the approval of the health organizations of the United Statesc and the opposition of a few commercially interested organizations.

Responses were made by representatives of the governments of 28 countries. Included in these were Argentina, Austria-Hungary, Bavaria, Bolivia, Brazil, Canada, Chile, Cuba, Denmark, France, Germany, Great Britain, Japan, Holland, Norway, Russia, Siam, Spain, Uraguay and Venezuela. Some of these responses were made by Washington representatives of the various governments, not necessarily delegates to the Congress.

Later in the opening day the delegates were received by President Taft at the White House. In the evening and again on Thursday evening, there was a reception at one of the public buildings.

The Plenary Sessions

Plenary sessions, for the whole Congress, were held on three evenings. At one of these, Sir Thomas Oliver, of Newcastle, England, a noted authority on occupational diseases, delivered an illustrated address on "Dust and Fume." At another session, Dr. Jaques Bertillon, Chief of the Bureau of Municipal Sta-

tistics, Paris, France, had for his topic, "Deaths and Causes of Deaths by Occupations." This was in French. Two others were in German. Only one address was given on each evening.

The Health Exhibition

An exhibition of health and demographic work in the United States, its dependencies, and in the several states and cities of the country was held in the Exhibition Building, close by the two buildings in which most of the sessions of the Congress were held. The exhibits were in 13 groups, which included vital statistics and demography, housing, communicable diseases, state and municipal hygiene and hygiene of traffic and transportation. Among other things, models and photographs of water-works and water purification, sewerage and sewage purification, were shown.

In addition, Traveling Health Cars used by the state boards of health of California, Louisiana and Maryland, were brought to Washington and were on exhibition at the Union Station. The California car was notable for its models illustrating in a homely but forcible way rural and municipal sanitary dangers and how to obviate them.

Numerous illustrated lectures were given in the Exhibition Hall, including one on water disinfection by ozone, violet rays, etc., by Ed. Imbeaux, of Passy, France.

The Sectional Meetings on State and Municipal Hygiene

First of all in this section came two long sessions devoted to Public Health Organization and Administration (jointly with Sec. VII, Traffic and Transportation). Great Britain, Germany, Denmark, Japan and the United States were included in the program, and for most of these countries both national and local administration were dealt with in considerable detail. The third session was devoted to the Sanitary Aspects of Water Supply, and the fourth to the Disposal of Sewage and Wastes. The fifth session was occupied with Public Health Education, the sixth with Housing, Rural Sanitation, and Ventilation, the seventh with Food Production and Control, and the eighth with Milk Production and Distribution.

The chairman of this section was Dr. Frank Wesbrook, of the University of Minnesota. Dr. Herbert Pease, of New York City, and Dr. Marshall Price, of Baltimore, Md., served as section secretaries.

Public Health Organization and Administration—When available in full printed form the dozen or more papers on this topic will be worthy the attention of all public-health students and administrators. (None of these papers were printed in abstract in advance.) The general plan followed was to have the work of the nation, the state or other secondary administrative unit and the municipality reviewed separately. This was done for Great Britain, Germany and the United States, by three persons in each case. There was also a group of papers on Denmark, one on Cuba, and one on the Canal Zone. The latter was not read. By an unfortunate accident the single paper on Japan, which had been prepared in English, was not called for. Almost as unfortunate for a majority of those present, the three papers dealing with the German Empire, Prussia and the German cities were read in German, without interpretation in abstract into English. The audience dwindled to perhaps 35 before the hour required to read these papers had passed. The papers were presented by Dr. Weber, of the Imperial Board of Health; Dr. Schneider, Royal Prussian Ministry of the Interior; and Dr. Kirstein, of Stettin.

England—"Central Public Health Administration in England" was presented by Dr. Theodore Thomson, Chief Assistant Medical Officer, Local Government Board, London. British health work falls under several different departments, including the Local Government Board, the Home Office (for Factories and Workshops), the Board of Education (School Medical Service), the Registrar General (Vital Statistics), the Army, the Navy, and lastly the National Insurance Committee. It is expected that the latter, which has charge of compulsory insurance, will ultimately have a great influence on public health.

The Local Government Board for England and Wales (there are separate boards for Scotland and Ireland) controls the design of all sewerage, water-works and other sanitary works built from the proceeds of loans. It has large health powers under the Housing and Town Planning Act of 1909.

Primarily, local authorities have control over health and sanitation. The Local Government Board can take action through the courts in case of local neglect, but seldom does so. Local health powers are largely adoptive by the local authorities, subject to approval of the Local Government Board. Many of the local health officers are appointed, subject to the approval of the board.

While the Local Government Board does a considerable amount of local investigation and issues many reports of educational value, the general rule in Great Britain is to appoint Royal Commissions to conduct research work—like the Royal Commission on Sewage Disposal [which has been "sitting" since 1898—Ed.].

Health control by administrative counties [towns and rural districts, outside of what we should call cities—Ed.] was described by Dr. George Reid, County Medical Officer of Health, Stafford, England. The early powers of county health officers were limited and, owing largely to the indifference of the county authorities, their achievements were small. The Housing and Town Planning Act of 1909 materially increased the powers and duties of these officers and the National Insurance Act of 1911 adds still more to their power for good. Altogether, they will now be able to do much to hold the smaller towns and the rural districts to the proper performance of their health and sanitary duties. The insurance act provides for the medical care of the millions who will be insured under it and is particularly far-reaching as regards tuberculosis.

The health and sanitary administration of Liverpool was outlined by Dr. E. W. Hope, Medical Officer of Health of that city. Health and sanitary powers are vested in the city council of 137 members, and entrusted to a sanitary committee of the council of 20 members. The direct administrative officers include a medical officer of health, a chief sanitary inspector, the city surveyor, the building inspector and a veterinary officer, besides three assistant medical health officers and numerous subordinates. The medical officer of health cannot be removed without the consent of the Local Government Board and half his salary is paid from the national treasury. All officers in the health department must have had special training for their work and generally they hold health diplomas or certificates and have been employed in health work since youth.

Denmark—All three of the Danish papers were presented in English. Physicus Johansen, Chief of Bureau, State Board of Health, described national health administration, which seems to be in a progressive state. It is becoming more and more common to hold typhoid patients in hospitals until examinations of their feces and urine show no typhoid germs. Children suffering from tuberculosis are excluded from school but are provided with home instruction at public expense.

A paper on "Progress in Hygiene in Denmark During the Last Half Century" was sent by Dr. I. Carlsen, Chief of Statistical Bureau, State Board of Health. He exhibited a series of diagrams which showed remarkable diminutions in the death rates from communicable diseases. The typhoid rate per 100,000 has fallen from 69.8 in 1865 to 43 in 1905, and tuberculosis from 244.7 to 130.7. Since about 1870 sewers have been introduced in 64 towns and water-supplies in 65 towns, out of a total of 74 towns in the kingdom.

"Some Legislative and Administrative Aspects of Public Health Engineering," by A. Bjerre, Public Health Engineer, Copenhagen, was presented in brief abstract by the author. He remarked that he did not know whether his audience would think it right for a city to go outside its boun-

daries, sink wells and draw the underground waters from many square miles of land without compensation. He also stated that Copenhagen has to pay large sums to men who dig deep holes near these wells and discharge polluting matter into them [perhaps to get even for the water taken without compensation—Ed.].

A new Danish sewer law provides that when sewers are to be extended the city concerned shall prepare plans and lay them before a commission consisting of a local judge and two men appointed by the ministry. Public hearings are held and attempts made to get the parties in interest to agree on the sizes and details of the sewers and on the distribution of the cost of the improvement. The city generally pays from 10 to 20% of the cost and the property owners benefitted the remainder. After "much study" the various commissions are coming to the conclusion that sewer costs should be apportioned according to property values rather than by areas served.

Cuba—A paper from Cuba claimed for that country the distinction of standing alone in having a sanitary officer in its cabinet (Public Health and Charities). The chief of the health bureau is secretary of a board of health, which has charge of the sanitary administration of cities and districts, quarantine against infection from abroad and the control of communicable diseases.

United States—Federal work for health was reviewed by Dr. John W. Kerr, Assistant Surgeon-General, U. S. Public Health Service, Washington, D. C. Besides port quarantine, the Public Health Service (as it is now called) has power to coöperate with local authorities, when requested, and since Aug. 12, 1912, has had specific authority to study water pollution and also the diseases of man. It has a hygienic laboratory and engages in both research and educational work. It intends to popularize its Bulletins and make them more valuable to individuals. The service now has 420 officers and a total personnel of 2000. In the foreign field, besides its medical officers it is represented by all consuls, wherever located. At home the service holds an annual conference with state health departments, the attending members of which thus virtually become an advisory board. In addition, there is a permanent advisory board of nine members, consisting of four government officials and five private scientists. The great need of the service is more men and money.

Municipal health administration in this country was assigned to Dr. Hermann M. Biggs, of the New York City Health Department. After saying that he thought the cities of the United States, as regards health work, were less hampered by precedent and possess more extensive powers than foreign cities, he confined himself almost wholly to health administration in New York City. Nowhere else in the world, the speaker said, are such broad legislative, administrative and judicial powers vested in a city health department as in New York. The health ordinances have the force of legislative acts and for thirty years past not a single court action against the board has been successful.

Discussion—For the discussion of the 12 to 15 papers on this important subject, which had occupied two sessions, 20 minutes was given. Drs. Sanders and Cunningham, of Alabama, advocated vesting health protection in medical men and praised the Alabama practice which constitutes the state and the various county medical associations, state and county boards of health. A doctor from Cleveland urged that the United States should spend less money preparing to fight its imaginary foes from without and devote more to putting down the real foes within.

The discussion was closed by Drs. Thomson and Biggs. Dr. Thomson remarked that while the Alabama system might be ideal, England was far from it. The people of that country have an idea that medical men are not good administrative officers. He thought the United States and Great Britain were tending to a middle line in health administration; the United States toward more, and Great Britain toward less centralization. Dr. Biggs said that we are coming to recognize pretty clearly that most health-protective problems are local in character; some are broader, like the control of water-supplies and sewage disposal, but most are local.

PUBLIC HEALTH EDUCATION—The education of health officers, sanitary engineers and the general public was considered under a number of well chosen heads. The leading paper, on "Training of Health Officers in the United Kingdom," was by Prof. G. H. F. Nuttall, of Cambridge University, England. The medical profession, the author said, has combined to work for health protection to its own financial loss, having reduced the average income of its members thereby. If it continues on the same course, incomes will fall below the living point.

Taking up his specific subject, Prof. Nuttall stated that the poor sort of men chosen as medical health officers after that office was provided for in 1872, led Cambridge University to provide means for obtaining a diploma of public health, the first of which was granted in 1875. Other universities have followed this example. At present candidates for a D.P.H. may begin their work immediately on concluding a full medical course, which course is a prerequisite. The prescribed work requires nine months' time, distributed between university instruction, six months under a medical officer of health and hospital work.

The author suggested various reforms in medical health officer education and status in Great Britain. A national standard for D.P.H. is needed. It would be well if the officer began his official life as a sanitary inspector, and served as an assistant medical officer before becoming full officer. Beginning with small towns there might well be promotions throughout one's whole career.

As to the status of the medical health officer, he is now dependent on the local authority, which is like making a factory inspector dependent on the factory owner. The health officer should be free from the local officer, secure in his position, entitled to a pension, and always be on full time and pay.

Prof. F. F. Wesbrook, Dean of the Medical College of the University of Minnesota, dealt with "Instruction in Hygiene in Medical Colleges and the Training of Health Officers." He opened by saying that doctors and lawyers as such are well paid, but health officers and sanitarians are not. A health officer should not be expected to get his education in the school of experience. Doctors, as such, are not health officers, nor are land surveyors fitted to be sanitary engineers. After suggesting that the present American courses in medicine and engineering, if followed by specialization for health or sanitary positions, carry a man well on toward 30 years before he can begin work, and after showing by the University of Minnesota as an illustration what facilities for the preparation of health and sanitary officers our universities already possess, if only coördinated, the author said that the next step forward will be a College of Public Health, manned from the medical, sanitary engineering and other departments.

"The Training of Sanitary Engineers" was well presented in a paper by Geo. C. Whipple, Professor of Sanitary Engineering in Harvard University, which we shall print in a later issue.

Prof. D. A. Sargent, Director of the Hemenway Gymnasium, Harvard University, took up physical training and education in hygiene in our higher educational institutions. Amherst, in 1860, was the first college to teach personal hygiene. At present, our colleges are divided between social and athletic aims on the one hand and intellectual aims on the other, and neither are hygienic. It is gratifying to note that a recent census showed that of the considerable number of colleges now having a department of physical training a large percentage give instruction in personal hygiene, in sanitation and in public health.

Prof. John W. Ritchie, of William and Mary College, Williamsburg, Va., dealt with "Elementary Training in Personal Hygiene in Private and Public Schools." Up to the end of the eighth grade such instruction does not total more than two

weeks in what is called physiology and hygiene, and some schools have no such instruction. The ideal plan would be to join medical inspection with the teaching of the laws of hygiene, including means for preventing the spread of communicable diseases.

"The Scope of the Official Department in Popular Education in Public Hygiene" was presented by Wm. F. Snow, Secretary of the California State Board of Health. The health department should not enter on educational work until it has financed and staffed its administrative work for the control of communicable diseases, the collection of vital statistics and the like. It may then begin to use for educational work its vast storehouse of statistics and material illustrating sanitary needs and measures to meet them.

Dr. Livingston Farrand dealt with the education and enlightenment of the general public in health matters. It is coming to be a common saying that we can have as much public health as we are willing to pay for. To get needed money and legislation on enlightened public opinion is necessary. The lecture, the exhibition, the pamphlet and above all the public press are means to this end.

Other papers took up the training of nurses and popular lectures for the general public. A country-wide lecture system on public and personal health is being given under the auspices of the American Medical Association.

Discussion — Dr. McRae, Vice-President of the Local Government Board of Scotland, said that many of the criticisms by Dr. Nuttall do not apply to health administration in Scotland, which is in advance of England in both health and education. The Scottish Act of 1875 is a charter of health. Medical health officers and sanitary inspectors cannot be turned out of office in Scotland.

HOUSING—Sir Geo. McCrea, Vice-President of the Local Government Board of Scotland, read an admirable paper on housing, relating chiefly to the British Housing and Town Planning Act of 1909. He thought that America had not shown her usual enterprise in recognizing the economic value of town planning. It is costing Great Britain millions of pounds to clear away the slums due to a lack of town planning. In Germany, Austria-Hungary and France, the author said, housing has suffered because of the attention given to town planning.

The British Town Planning and Housing Act enables the Local Government Board to limit the number of houses on an acre. This will lessen rents and result in ealier development, for high rents are fostered by permitting many houses to be built on a given area. Thus in Edinburgh land closely built upon for working-class houses commands a yearly ground rental of $1250 per acre, against $100 to $200 for houses well spaced and occupied by the well-to-do. America has great need for housing legislation, where towns spring up overnight.

"Sanitary Aspects of Housing Problems" was tellingly presented by Robert W. DeForest, one-time Tenement House Commissioner of New York City. Progress must wait on public education. Laws can be repealed but knowledge abides. Thus bath tubs in houses are nowhere required by law but are becoming almost universal because the public has learned their value. Though not compulsory in New York City, 87.7% of the tenement houses built in the past ten years have a bath to each suite, 4.2% have at least one bath tub in the building and only 8.1% are without bath tubs. These tenement houses number over 28,000, provide nearly 350,000 rooms and presumably house 1,600,000 people.

Building regulation was a late arrival in this country. The first tenement-house law (New York) was not passed until the sixties. Now New Jersey, California, Massachusetts, Pennsylvania and one other state have such laws. Two years ago only ten cities in the United States were active for better housing, now the number has reached a hundred.

Two papers from France were presented. The author of one of these said it was time to quit the "five-minute habit" of copying one's neighbor without regard to varying local conditions. The city should possess land enough, he urged, to prevent speculative and prohibitive prices for land needed for proper housing.

RURAL HYGIENE AND SANITATION—H. N. Ogden, Professor of Sanitary Engineering, Cornell University, opened this subject with a paper in which he analyzed the urban and rural population of New York State and compared the general and special death rates of the two classes of population. The showing would be much better for the country if its people lived up to their natural opportunities.

Dr. J. N. Hurty, Secretary of the Indiana State Board of Health, described the insanitary and unhygienic conditions which prevail on about 80% of the farms of the Central West. Many of the houses are built flat on the ground, privies and wells are in close proximity, and bath tubs are almost unknown. Bad house air, polluted drinking water, fried food, neglected teeth and unclean mouths devitalize the people, and patent medicines, alcoholism and the drug habit complete the wrecks. Only a small percentage of the schoolhouses are sanitary.

VENTILATION—A paper on this topic, by D. D. Kimball, of New York, reviewed some of the important engineering phases of ventilation and one by Prof. C.-E. A. Winslow, also of New York, presented the newer conception of ventilation, which is based on controlling temperature and humidity, rather than being aimed at carbon dioxide and organic matter in the expired breath. We expect to print abstracts of both papers in a later issue.

WATER-SUPPLY AND SEWAGE DISPOSAL —Two groups of important papers on these subjects will receive attention in a later issue.

REFUSE DISPOSAL—The collection and disposal of garbage, ashes, rubbish and allied wastes was covered by Rudolph Hering, of New York City, whose ideas on these subjects are well known to many of our readers. Emil Kern, of Paris, Rrance, described waste disposal in France. The mixed refuse of Paris is separated after collection and the garbage and some other wastes are ground or shredded and used on land.

OTHER SECTIONAL MEETINGS

Closely related to the section on State and Municipal Hygiene was the one dealing with the control of infectious diseases, which included numerous papers on disinfection, yellow and typhoid fevers, tuberculosis, flies, shellfish, bacillus carriers and antityphoid and other vaccination. Abstracts of some of these papers, together with some on related topics, presented before other sections, will be given in a later issue.

MILK—A group of papers on the administrative control of public milk supplies has already been mentioned. In "A Bacteriological Examination of Market Milks," Dr. P. G. Heineman, of the University of Chicago, stated that a recent study designed "to discover more precise methods of routine examinations of milk" produced no results which would warrant a departure from present laboratory methods. However, the investigations were otherwise fruitful to the following extent:

> Examination of 215 samples of milk bought in the open market in original packages showed that pasteurized milk, as sold in Chicago today, is cleaner than raw milk. It contains less than one-fourth the number of bacteria contained in raw milk. This number would be much smaller, if pasteurization were universally of high efficiency. Methods of commercial pasteurization of milk are still in a stage of evolution, but development has progressed to a degree which will insure efficient pasteurization within a few years.
>
> The fact was also brought out, that pasteurized milk turns sour the same as raw milk, the process being somewhat delayed.
>
> The quantitative determination of several species of germs commonly found in milk was made. Species originating from cow manure were selected in the hope of finding some relation between numbers of these species and the amount of dirt. The results were not conclusive. There can be little doubt but that there is some relation between these species and the amount of dirt in fresh milk. This can be true, however, only at the point of production. By subsequent multiplication of germs during transportation the relation is shifted, so that in market milk no true indication of dirt can be found by counting the numbers of species. Only the total number of bacteria can serve as an index of dirt in milk.

A study of the economies of milk distribution at Rochester, N. Y., based on 40 dairy farms, 173 milk vendors, the use of milk in 5400 homes, and an experimental investigation of milk delivery under better conditions was presented by

Dr. John R. Williams, of Rochester, N. Y. Among other things he concluded that milk dairymen are using land too valuable for the purpose; that most of them waste manure; and that by lessening the number of vendors, cutting out overlapping routes, and effecting various other economies the present cost of milk distribution [which makes up a large proportion of total cost] could be reduced by three-fourths.

The long program for the section of Traffic and Transportation took up many phases of the sanitation of street and steam railways, ships and shipping, the protection of employees and passengers from accident, and national and state regulational traffic and transportation. Abstracts of some of these papers will appear in later issues of this journal.

Equally full was the program on Military, Naval and Tropical Hygiene. Among other things this dealt with camp hygiene, malaria, and an international basis for naval statistics.

Under Hygiene of Occupation came a long list of papers on risks and accidents, safety devices, occupational diseases and the smoke nuisance in cities. Some of these papers have been reserved for later treatment, as have a number of papers presented to the section on Demography.

Annual Convention of the International Association for the Prevention of Smoke

The seventh annual convention was held at Indianapolis, Ind., Sept. 25 to 27, with a good attendance representing numerous cities and various interests, public and private. Three business sessions were held, and a dinner and other entertainments were provided. One afternoon was devoted to an interesting trip on the Indianapolis Belt Line, which traverses the manufacturing district and serves a number of outlying factories and other coal-consuming industries. The train consisted of coaches and open freight cars fitted with seats, the latter affording good opportunity to observe the smoke conditions, especially at such infrequent times as the engine did not rain a shower of cinders upon the train. A stop was made at the automobile speedway, where two exhibition races were run, and another stop at the new Beech Grove shops of the C., C., C. & St. L. Ry. John Krause (Cleveland, Ohio) was elected secretary at the opening meeting. He succeeds R. C. Harris (Toronto, Canada) who had been secretary since the society was organized, but had resigned. A silver bowl was presented to Mr. Harris in token of the society's appreciation of his work.

Relation of Smoke to Public Health and Welfare

This phase of the situation was discussed at the first day's session, and Dr. J. A. Beck (University of Pittsburgh) referred to the liability of serious affection of the lungs in persons living in smoky cities. At Pittsburgh (and at Chicago and Cleveland also, we may note) research is being made as to the effect of smoke and gases on health conditions, on buildings, on the furnishings of residences, on the stock in retail and wholesale stores, on street cleaning, on trees and plants, etc. This includes a consideration of the cost of the damaging effects. Visible smoke is only one part of the trouble, as the noxious gases due to combustion or imperfect combustion are invisible and therefore sometimes neglected in a movement for smoke prevention. R. C. Harris (Toronto) said that some people objected to such a movement as being unfavorable to a city's business, not realizing that smoke is not a sign of prosperity but rather of neglect, waste or bad management. E. P. Roberts (Smoke Inspector of Cleveland) estimated the yearly cost or loss due to smoke at $12 per capita for Cleveland and $8 for Chicago.

The Abatement of Locomotive Smoke

One session was assigned to this branch of the subject, and was opened with a paper on "The Elimination of Black Smoke from Locomotives," by D. R. MacBain, Superintendent of Motive Power, N. Y. Central Lines, Cleveland, Ohio. The author, however, was not present. The paper showed that with careful firemen properly instructed, heavy passenger and freight trains have been taken from the starting point to a distance of as much as 15 miles without emitting black smoke. But as the supply of skilled and intelligent firemen is not sufficient, it is necessary to evolve some mechanical device or method. The conditions necessary to avoid the emission of smoke on hand-fired engines on terminal divisions were listed as follows: 1, boiler and firebox in as perfect condition as possible; 2, careful and intelligent effort by the engine crew; 3, proper care of boiler appurtenances; 4, a good blower of sufficient size; 5, a steam jet arrangement to cause an induced draft of air above the fire when needed; 6, a brick arch of proper design; 7, good drafting, so that forcing of the fire will be unnecessary; 8, a well proportioned superheater; 9, the proper cleansing of smoke emitted from engines being fired up at engine houses.

For the draft arrangement, Mr. MacBain advocates a nozzle of rectangular section, and a smokestack diameter four times that of a circle having an area equal to that of the rectangular nozzle, while the openings under the diaphragm should be not less than 80% of the total tube area. The steam jet from the nozzle should at no time completely fill the stack, as this will choke the flow of gases; it should leave a liberal annular space which will be filled by the gases, which are thus entrained with the steam and carried out without interference. The stack should be extended into the smoke-box to within a short distance above the nozzle, and its height above the boiler should be sufficient only to carry the gases clear on the cab; otherwise, with a small stack diameter, the exhaust jet will fill the stack. The firedoor should provide a permanent opening of not less than 12½% of the door area. Under the conditions noted, large double-crew switch engines have worked for a year without heavy smoke and without having a tube expanded or calked. As to preventing smoke from engines being fired up at engine-houses, Mr. MacBain considers that no plan has been developed that will deal effectively with this problem. The solution lies in cleaning the smoke after it is discharged from the engine and before it is discharged into the atmosphere. Experiments are to be made at Chicago with a device which will take out practically all of the unconsumed carbon and 75% of the acids and gases.

The discussion turned largely on the education and efficiency of the firemen, but as this force is continually changing it is impossible to have more than a rather small percentage of skilled men. Furthermore, it is a difficult matter to get the men to obey instructions when not under the eye of a superior, and many of them do not care or desire to learn improved methods. One speaker said that on his road the engineman is held responsible for smoke, as he is in charge of the engine and the fireman is under his orders. Hr. Houghton (C., C., C. & St. L. Ry.) noted special conditions at Indianapolis, where trains leaving the station immediately strike an up-grade and reverse curve which result in putting a sudden load on the engine. If a heavy fire is maintained in the station, the safety valves will blow and cause a nuisance, but if a moderate fire is kept it is impossible to keep the necessary pressure and yet avoid smoke when the train starts. Mr. Brown (City Smoke Inspector) thought that relief under such conditions could be effected easily by the use of an assisting engine. It might be noted, however, that a better solution would be the elimination of such severe grade and curve conditions. In fact, Mr. Lewis (C., B. & Q. R.R.) thought smoke prevention would be much easier if the railways would spend more money in this direction.

Mr. Brown commented also upon the variation in smoke ordinances and smoke-prevention methods at different cities, and suggested that there should be some coöperation to effect greater uniformity.

Very little was said as to switching engines and roundhouse conditions, which are two of the leading factors in the smoke nuisance in cities. However, two speakers mentioned the value of delivering steam and hot water to boilers being fired up in the engine-houses, both to economize in fuel and to reduce smoke. Nor was reference made to the public agitation for electrification of terminals, although the smoke nuisance is generally at the bottom of such agitation. A few thousand dollars spent in abating this nuisance might greatly improve public feeling and at least defer the prospective enforced expenditure of millions for electrification.

Factors in Combustion

A short paper by W. T. Mead (Indianapolis) on "Perfect Combustion" precipitated a lively discussion which disclosed many of the practical factors affecting the proper combustion of fuel. In this discussion Mr. Mead said that in spite of all mechanical devices the ultimate result is largely due to the human factor, for even the best mechanical stokers will cause smoke if they are not properly operated. The company of which he is operating engineer was indicted several times for smoky chimneys and the company insisted that he and the plant manager must prevent the trouble. Various changes were made in grates, draft appliances, etc., and then the enginemen and firemen were made clearly to understand that smoke need not occur if the fires were handled strictly and continually in accordance with the instructions given. If a man could not or would not follow instructions he would have to leave. There has been no more trouble with smoke and very few changes have been made in the staff for several years. However, many plants cannot get men who will stay, or men of sufficient skill and intelligence to follow instructions regularly.

Another point brought out was the great importance of draft appliances, and inspection of many smoky plants has shown that defects in this respect are responsible for a large percentage of smoke troubles. This applies to many large and presumably well designed plants as well as to small plants. The troubles lie in two directions: first, in failure to provide capacity for sufficient air to enter the boiler room and, second, failure to provide or maintain sufficient capacity in the breeching and smoke flues leading to the stack, the original capacity being often reduced by collections of dirt or the placing of obstructions. The damper arrangement also is frequently a source of trouble. These defective features are usually discovered only after continual trouble, resulting in a thorough examination of existing conditions. Mr. Brossman referred to the difficulties of securing proper air capacity and other facilities in the plants of large buildings, and the troubles incident to increasing the size of such plants in existing buildings.

In regard to fuel other than coke, the use of wood refuse at sawmills and woodworking plants was mentioned. In many cases, the refuse is delivered direct to the furnace, and when all machines happen to be working together the furnace becomes so choked that great quantities of smoke are discharged. In one case, the refuse has been diverted to a bin, the feed from which is regulated by the fireman, and in another there is a "Dutch oven" formed as an extension of the furnace. A mirror has been fitted so that the fireman can see the condition at the top of the stack and regulate his fire accordingly. Mr. Mead referred to the once general use of natural gas for fuel in Indiana, and the practically entire loss of this fuel by wasteful and extravagant methods. The growing use of coke for domestic fuel was described by a representative of the byproduct gas plant of Indianapolis, and he stated that the thousands of smoky chimneys of residences constituted a much larger feature of the smoke nuisance than is generally recognized, since it is not so readily seen as the discharge of a volume of smoke from the chimney of a large manufacturing plant.

Central States Water Works Association

The sixteenth annual convention of the Central States Water Works Association was held at Detroit, Mich., Sept. 24 to 26. The reported attendance was 76, of which 38 were either active members or else guests more or less closely connected with water-works management, 28 were supply and material men and 10 were guests. Fourteen new members were elected.

As is often the case at the meetings of the smaller and less pretentious societies, the discussion at this convention was remarkably full and free. Questions were asked and answered without restraint, and personal experiences pertaining to specific problems and based on operations at specified water-works were given.

In his presidential address, Wiliam J. Scroggins, superintendent of water-works, Wheeling, W. Va., paid a tribute to Detroit and its water-works. He spoke for the elimination of politics from water-works management and urged continued devotion to the work of the Association.

Lengthy papers on "Depreciation," by Halford Erickson, chairman of the Railroad Commission of Wisconsin, and a paper on "The Wisconsin Utility Law," by C. B. Salmon, president of the Water, Gas & Electric Co., of Beloit, Wis., which also dealt with depreciation, brought out considerable discussion on public-service commissions but little or none on depreciation.

In answer to questions Mr. Erickson stated that the engineering force of the Wisconsin Railroad Commission is now about thirty in number, being temporarily increased by the large amount of appraisal work in progress, including that done in coöperation with the State Tax Commission. The cost of the work done by the Railroad Commission has increased from about $50,000 the first year to some $115,000 for this year. He also said that the commission is compelling municipally owned water-works to raise their rates, and to put into use a uniform system of accounts, classified for four groups of cities, according to size. Generally speaking, Mr. Erickson was of the opinion that municipal plants are not so economically managed as private plants, but so far as politics are concerned conditions are improving.

Mr. Erickson also stated, in response to further questions, that where local public opinion warrants it rates of municipally owned plants are set at a figure sufficiently high to earn interest on the total cost of the works, which he regarded as just to citizens whose money is invested in water-works.

Meters are required by the Wisconsin Commission as rapidly as circumstances will permit. These, and service connections to the curb line, ought to be paid for by the company or city rather than by the water consumer.

R. P. Bricker, Shelby, Ohio, stated that he would like to see public service commissions in every State of the Union, in charge of municipal as well as private water-works. The Ohio Commission, which has been in existence about a year, has no control of municipal plants.

Mr. Salmon, in answer to a question prompted by his paper, stated that the Wisconsin Commission places the burden of fire protection upon the general city treasury, proportioning it according to capital and operating cost of fire protection.

A paper on "Fire Protection," by C. W. Wiles, Delaware, Ohio, raised the old and vexed question of fire services for private fire protection. He argued that instead of complying with the greedy and self-defeating demands of the fire-insurance men and laying 6- or 8-in. automatic-sprinkler connections from an 8-in. street main, no such connection should be more than 4 in. in diameter; if that is insufficient for a building, then lay a second 4-in. connection, on another street or side of the building. He also urged that all private fire services be metered, as is now required by more than 80 cities.

In discussing this paper, George Houston, Water Commissioner, of Kalamazoo, Mich., gave some of his experiences with people who used water from fire-protection lines without paying for it until

compelled to do so by lawsuits. He advocated a radical remedy, that of compelling factories to furnish their own fire-protection service.

The general discussion showed a consensus of opinion to the effect that the insurance people ask more in respect to fire-protection services than most people are willing to pay for if installed, and that the size of such lines as are demanded by the underwriters is too large in many cases and if granted would seriously menace the fire protection afforded to the general public, especially in the smaller places where the falling of a wall on a 4-in. main valve might cripple the entire water-works department during a fire, and leave the city helpless in the event of another fire immediately following the first one.

F. H. Frost, Akron, Ohio, said that all fire services there are to be provided with detector meters.

In a paper on "Water Rates," written from the viewpoint of the responsible superintendent or other operating authority, Philip Burgess, of Columbus, Ohio, discussed various popular phases of his subject, including the general uninformed state of public opinion as to the just basis for rates. Division of cost of service between private and public consumers was, of course, advocated. Examples were presented to show that the water revenues of some works that are not paying expenses might be raised without opposition by providing purer water; even making possible an increase in rates instead of a demand for lower rates on account of poor service. Proper water-works accounting was advocated and provision for depreciation.

A number of papers bearing on water treatment have been reserved for abstract in a later issue, together with some notes on the voluminous discussion which they brought out. Finally, as regards the papers, one entitled "Stop the Waste" was presented by Alba L. Holmes, of Grand Rapids, Mich.

Before the convention closed, the Executive Committee was authorized to make an investigation of the fire premiums paid by water companies in the Central States and the fire losses paid to these companies. J. C. Martin, vice-president of the Wilmington Water & Light Co. (Ohio), who made this motion, said that this would be in line with the action already taken by the Ohio Electric Light Association. He explained that the moral hazard was nil in the case of water-works companies, as the central station could not be put out of commission without endangering the general supply system, and seriously damaging the revenue for which the investment was created. And further that the amount of premiums paid for fire insurance is ridiculously out of line with the amount of losses paid by the electric-light companies and presumably by the water-works as well.

F. B. Leopold, of Pittsburgh, Penn., described the steps already taken by the Central States Water-Works Association for affiliation with the American Water-Works Association and predicted that the result would be added prestige to the water-works men in handling any public question affecting their interests generally. On motion of Mr. Leopold, a committee was authorized to take up the matter of affiliation with the American Water-Works Association. Finally this subject was referred to the Executive Committee.

The leading officers for the ensuing year are: President, J. C. Beardsley, a former water-works man, now representative of the Thomson Meter Co., Cleveland, Ohio; Secretary, R. P. Bricker, Secretary of the Shelby Water Co., Shelby, Ohio; Treasurer, A. W. Inman, Secretary of the Massillon Water Supply Co., Massillon, Ohio.

The next place of meeting was fixed at the "Breakers Hotel, Cedar Point on Lake Erie," probably in August next, but at some date not again conflicting with the convention of the New England Water-Works Association, as was the case this year.

In a Derailment on the Southern Railway, near Plainville, Ga., on Sept. 25, two persons were killed and ten injured. Two day coaches and two sleeping cars left the track.

A Derailment on the Grand Trunk Ry., near Chatham, Ont., on Sept. 26, caused the injury of 12 persons, one of whom was probably fatally hurt. Spreading rails or a broken rail are explanations advanced by the railway officials.

The Collision of Two Passenger Steamers on the Dvina River, near Archangel, Russia, on Sept. 23, resulted, according to cable dispatches, in the drowning of 115 persons, passengers on one of the steamers.

A Grade Crossing Collision occurred at Denver, Colo., on Sept. 19, between a trailer car of the Denver City Tramway Co. and an express train on the Union Pacific R.R. Two were killed and two seriously injured among the passengers on the trailer car, which was struck and demolished by the train. The crossing has been guarded during the day time by a flagman, supplied by the railroad company, but has been unguarded at night. Press reports indicate that in this case the Tramway company was to blame for not guarding the crossing at night.

Railroad Accidents in New York City, during August, according to the Public Service Commission reports, caused injury to 4334 persons, of which 2970 were passengers, 635 were employees, and 729 were neither employees nor passengers. Of this number 27 persons were fatally injured, and 242 were seriously hurt.

The Grounding of a Signal Cable in the Hudson Tubes, between New York and Jersey City, on Sept. 24, caused a block of half an hour, during which time lights were shut off from several trains in the tubes. In order to locate the ground and make the necessary repairs, the power had to be shut off in the tunnels, but men with lanterns were sent out from both terminals and a panic was avoided. Every delay of over one minute on this system is the subject of rigid investigation, and the service given has been remarkably efficient and reliable.

The S.S. "Stephano" Ran Into Pier 1, North River, New York City, on Sept. 26, and both the pier and the boat's hull were badly damaged. The office of the New York Dock Commissioner, which is on the second floor of the pier, was wrecked in the collision. A strong tidal current caught the boat, while rounding the Battery preparatory to docking, and carried it against the pier.

An Explosion on the Destroyer "Walke," on Oct. 1, killed three men and injured six. The boat was making speed trials in a heavy sea off Brenton's Reef Lightship, near Newport, R. I., when, it is reported, her port turbine blew off its head casing and steam chest. Perfect discipline was maintained, relief measures were instituted promptly, and the destroyer was able to reach port unassisted, running at half speed, driven by her starboard turbine, which was uninjured.

The Mine Explosion at Bruay, France, on Sept. 4, is stated officially to have cost 60 lives. The disaster occurred at the Clarence pit, and is attributed to the ignition of a pocket of firedamp. Continued explosions blocked the rescue work and set fire to the workings, so that it was decided best to stop up the mine until the fires should burn out, instead of trying to remove the remaining bodies.

A Fire in the Wyandotte Plant of the Detroit Shipbuilding Co., at Detroit, Mich., on Sept. 28, caused damage amounting to over $200,000, according to press reports. The company's valuable collection of ship models, and also a $1,500,000 excursion steamer in process of construction, were reported saved, but a large part of the plant was destroyed.

Panama Canal Excavation during August totaled 2,443,353 cu.yd., a daily average of 90,495 ⅓ cu.yd. for the 27 working days. The monthly rainfall was 11.98 in. The amount of concrete laid in August was 89,879 cu.yd. and 302,239 cu.yd. of fill was placed in dams.

A Contract for 2,000,000 Cu.ft. of gas per day has been secured from the Ford Motor Co., makers of automobiles, by the Detroit City Gas Co. To take on this load, it is reported, the company will have to invest $580,000 in plant, including a 3,000,000-cu.ft. holder at the Ford works and three miles of 12-in. high-pressure mains. It is also reported that a load of 6,000,000 cu.ft. is expected if plans are carried out to increase the output of the Ford plant to 1000 cars per day. The gas will be used for motive power and heating.

A Maximum Speed of Seventy Miles per hour has been fixed by general orders on the Pennsylvania R.R. While the passenger schedules have been so arranged that speeds in excess of this are required at very few places when trains are running on time, the present general orders are especially intended to affect trains which may get behind their schedules and endeavor to make up time. Enginemen are instructed that under no

circumstances is the maximum speed of 70 miles per hour to be exceeded. In addition, existing restrictions of speed on sharp curves are to be made more definite by the installation of special signals wherever the curvature of the track is such that the speed must be reduced to 45 miles per hour or less. It may be remarked that in order to make the new instructions thoroughly effective, it will probably be necessary to install automatic speed recorders in the engine cabs. Without some such device it is very difficult for an engine runner to tell with any approach to accuracy how fast his train is running.

The Parcels Post service in connection with the U. S. Post Office Department will start Jan. 1, 1913. While the matter was up for consideration by Congress there was prolonged discussion as to whether flat rates should be charged on matter handled in this way, or whether a graduated scale of rates should be charged depending on the distance carried. This latter method, known as the "zone system" of rates; was championed by Senator Bourne, chairman of the Senate Committee, on Post Offices, and was finally decided upon as the most efficient way to charge for the service. The scale of rates under the "zone system" is given in Section 8 of the law entitled, "An Act making appropriations for the service of the Post Office Department for the fiscal year ending June 30, 1913, and for other purposes," approved Aug. 24, 1912.

The Management of Irrigation Properties by a company organized specially to manage and operate such properties, in order to ensure economy and efficiency, is the purpose of the Irrigation Service Co., established recently at Fort Collins, Colo. It is claimed that under this system there will be an economical and impartial distribution of the water, a low cost of operation, and a permanent policy of administration under contracts covering a term of years. C. R. Hedke, M.Am. Soc. C.E., is engineering manager of the company.

A Traction load of 26,200 kw. has recently been contracted for by the Philadelphia Rapid Transit Co. with the Philadelphia Electric Co. As a result, the operating stations of the traction company will be shut down, or converted into sub-stations operated by the electric company which is required to supply direct current in some other districts. This change is covered by separate contracts for three districts known as the "Central", "Northern" and "Delaware County." The first of these contracts provides for the simple sale and purchase of high-tension alternating current to be delivered at the Sansom St. sub-station of the traction company and also at a sub-station now being built to be occupied jointly by the two companies. Furthermore, 5000 kw. in addition to the initial 15,000 kw. of this contract, is to be delivered in 1913 at a new sub-station not yet designed. The second contract noted calls for the purchase of 5000 kw. of direct-current energy, the sub-station apparatus and operating force to besupplied by the central-station company. This current will be supplied from the Tacony station of the central-station company, to four stations of the traction company, these stations to be occupied at a nominal rental and the central-station company to have the privilege of utilizing the existing generating machinery in case of any trouble with its own converting equipment. The third contract was made with subsidiaries of the Philadelphia Electric Co., and calls for 1200 kw. of direct-current energy. This will be furnished from the subsidiary companies' own sub-stations and from one station of the traction company to be occupied at a nominal rental. Under the first two contracts noted, the Traction Company guarantees a 35% load factor and on the third contract 30%. All contracts are to run for a period of 10 years.

A new Union Terminal Station at Chicago is to replace the present Union Station at Canal and Adams Sts. This station serves five railways, and is a double-end terminal that is, it is approached from both ends, but no trains run through the station. The Pittsburgh, Fort Wayne & Chicago R.R., Chicago & Alton R.R. and Chicago, Burlington & Quincy R.R. enter at the south end; the Pittsburgh, Cincinnati, Chicago & St. Louis R.R. and the Chicago, Milwaukee & St. Paul R.R. enter at the north. There are at present about 260 trains daily, and the traffic averages nealy 50,000 passengers daily, only a small proportion of this is suburban traffic. The trainshed accommodates only a few tracks, and all the facilities for passengers and trains are both inadequate and inconvenient. The tracks are below the street level, on the strip of land between Canal St. and the river, and this arrangement will be retained. There will be 26 tracks in the new station, with a trainshed of the Bush low-roof type. It is probable that it will be made somewhat higher than that of the Chicago & Northwestern R.R. station in Chicago (Engineering News, Aug. 17 1911), as the latter has been found to be inconveniently dark. Even in light summer weather lamps have to be lighted on trains standing in the station, and lamps are lighted on incoming trains as soon as they reach the approaches. As only a few lamps are lighted, there is confusion among passengers especially in handling their baggage.

The station building of the new Union Station will occupy the entire block between Canal, Clinton and Adams Sts. and Jackson Boulevard. The concourse will be on a mezzanine floor between the street level and the track level, and will extend under Canal St. For the convenience of suburban passengers a subway will be built under the Chicago river extending from the station concourse to Quincy St. The architects for the station are D. H. Burnham & Co. The total cost of the new terminal, including the extensive system of approaches for the several railways, is estimated at $35,000,000.

Personals

Mr. W. O. Jacquette has been elected Vice-President of the American Shop Equipment Co., of Chicago, Ill., with offices at 30 Church St., New York City.

Mr. J. T. Cheek, formerly Trainmaster of the National Rys. of Mexico, has been appointed Superintendent at Gomez Palacio, succeeding the late A. T. Chreitzberg.

Mr. B. C. Stevenson, formerly Assistant Freight Traffic Manager of the Toledo, St. Louis & Western R.R., has been elected Vice-President in charge of traffic.

Mr. Geo. A. Ralph, State Drainage Commissioner of Minnesota for the past 12 years, has resigned, effective Jan. 1, to engage in consulting drainage work in Kentucky.

Mr. C. E. Grunsky, Jr., of the American Engineering Corporation, San Francisco, Calif., has been appointed Superintendent of the Standard Consolidated Mining Co., at Bodie, Calif.

Mr. N. D. Maher, Second Vice-President and General Manager of the Norfolk & Western Ry., has been elected Chairman of the Board of Directors, succeeding the late Henry Fink.

Mr. H. W. Hamilton has been appointed Assistant Superintendent of the Northern division of the Chicago Great Western R.R., succeeding Mr. C. W. Cool, assigned to other duties.

Mr. Robert F. Pack, Assoc. Am. Inst. E. E., until recently General Manager of the Toronto (Ont.) Electric Co., has been appointed General Manager of the Minneapolis General Electric Co.

Mr. B. L. Bugg has resigned as Traffic Manager of the Norfolk Southern R.R., at Norfolk, Va., to accept a similar position with the Atlanta, Birmingham & Atlantic R.R., at Atlanta, Ga.

Mr. C. S. Mellen, President of the New York, New Haven & Hartford R.R., has been elected President of the New York, Ontario & Western Ry. also, succeeding Mr. Thomas P. Fowler, resigned.

Mr. X. H. Cornell, recently Superintendent of Transportation of the Chicago & Alton R.R., has been appointed Superintendent of Transportation of the Pere Marquette R.R., with headquarters at Detroit, Mich.

Mr. B. A. Brennen has resigned as Sales Manager of the power department of the Bethlehem Steel Co. to accept the office of Manager of the corporation department of the Mercantile Trust Co., of St. Louis, Mo.

Mr. H. B. Walker, Deputy State Engineer, in charge of drainage and irrigation, Kansas State Agricultural College, Manhattan, Kan., was married on Sept. 11, to Miss Cora L. Harris, at the home of the bride in McComb, Ill.

Mr. J. Frank Haig has been appointed Purchasing Agent of the Pennsylvania Steel Co., succeeding Mr. Stedman Bent, resigned. Mr. Haig's headquarters will be at the company's general offices in the Morris Bldg., Philadelphia, Penn.

Mr. R. S. Marshall, former Assistant to the Vice-President and General Manager of the Minneapolis & St. Louis R.R., at Minneapolis, Minn., has been appointed Superintendent at Oskaloosa, Iowa, succeeding Mr. H. G. Kruse, retired.

Messrs. Lucius I. Wightman and Paul Morse Richards have entered into a partnership under the firm name of Wightman & Richards, consulting engineers in technical advertising, forming the technical department of Jos. A. Richards and staff, Tribune Bldg., New York City.

Mr. J. E. Spurrier, Division Superintendent of the Baltimore & Ohio R.R., at Winchester, Va., has been promoted to a position on the staff of the General Manager with headquarters at Baltimore, Md. Mr. G. D. Brooke, formerly Assistant Superintendent at Keyser, W. Va., succeeds Mr. Spurrier at Winchester.

Mr. Frank B. Moody, Assistant State Forester of Wisconsin, has been appointed Assistant Professor of Forestry at the University of Wisconsin, at Madison. Prof. Moody is a graduate of the forestry school of the University of Michigan, and has been in charge of the

field work of the Wisconsin State Forest Service for a number of years.

Mr. Louis M. Pawlett, Assoc. Am. Inst. E. E., has resigned as Executive Engineer of the Locomobile Co. of America to engage in private practice in consulting and development work in all departments of motor transportation engineering, with offices at 1786 Broadway, New York City.

Mr. W. S. Tinsman, Assistant to the President of the Chicago, Rock Island & Pacific Ry., has been elected Chairman of the General Managers' Association of Chicago, succeeding Mr. W. A. Garrett, whose election to the vice-presidency of the Chicago Great Western R.R. is noted elsewhere in this issue.

Mr. Wm. T. Donnelly, M. Am. Soc. M. E., Consulting Engineer, of New York City, has been appointed Consulting Engineer of the New London, Conn., Harbor Commission, which includes the Governor of the state and the Mayor of New London. About $2,000,000 have been made available for extensive harbor improvements at New London, which is to become an important terminus of the Grand Trunk Ry.

Mr. H. R. Bricker has been appointed Labor Agent of the Baltimore & Ohio R.R., at Baltimore, Md., a newly created position to head a department, the purpose of which will be to bring the unemployed, or those wishing to better their conditions, in direct touch with possible engagements for both skilled and unskilled employees in railway work. Branch offices will be maintained in Philadelphia, Washington, Cincinnati, Cleveland and Chicago.

Mr. Leslie C. Frank, an engineer connected with the Baltimore Sewerage Commission, has resigned to accept a position in sewerage work in Germany. In presenting his resignation to the Commission, Mr. Calvin W. Hendrick, M. Am. Soc. C. E., Chief Engineer, is reported to have said that the Baltimore sewerage work had proved a veritable training school for sewer engineers, and that engineers formerly connected with this work were now occupying responsible positions in China, Japan, England, France, the Philippines, Mexico and Panama.

Mr. W. A. Garrett, recently Chairman of the General Managers' Association of Chicago, has been elected Vice-President in charge of operation of the Chicago Great Western R.R., at Chicago, Ill. Mr. Garrett was President of the Seaboard Air Line Ry. from 1906 to 1909, and was the official delegate of the United States to the International Railway Congress at Berne, Switzerland, in 1910. Previous to becoming President of the Seaboard Air Line Ry., Mr. Garrett was Division Superintendent and General Superintendent of the Philadelphia & Reading Ry. (1899-1903), and General Manager of the Cincinnati, New Orleans & Texas Pacific Ry. and the Alabama Great Southern R.R. (1903-1906).

Mr. Bion J. Arnold, Past-President Am. Inst. E. E., of Chicago, has been retained by the Pacific Gas & Electric Co., of San Francisco, Calif., to investigate street railway conditions in Sacramento, Calif., where it operates all of the urban lines. This investigation has for its object, the determination of the present and future needs of the traction system, and the possibilities of developing the traction district, within the limits of a reasonable return upon the value of the property. Mr. Arnold has recently engaged in similar investigations in the cities of San Francisco, Calif., and Providence, R. I., and the work at Sacramento will be organized and directed by Mr. J. R. Bibbins, who has been resident engineer for Mr. Arnold in the other two investigations above mentioned.

Obituary

William Rose Rombough, for many years a Dominion land surveyor, died at his home in Toronto, Ont., on Sept. 20, at the age of 91 years.

John T. Cowling, Assoc. Am. Inst. E. E., Electrical Engineer of the Westchester Lighting Co., Mt. Vernon, N. Y., died Sept. 19, at Fullerton, Calif., where he went about a year ago in search of health. He is survived by a widow and two children.

Lawrence B. Fay, a civil engineering graduate of Cornell University, class of 1906, and an assistant engineer with the Isthmian Canal Commission at Panama, was killed on Sept. 17 by a fall from the top of the lock wall at Gatun. Previous to his work on the Panama Canal Mr. Fay was employed on the engineering staff of Mr. Hugh L. Cooper, Consulting Engineer, on the McCall Ferry hydroelectric development.

John Forsyth Hanscom, Rear-Admiral, U. S. N., retired, died at his home in Philadelphia, Penn., Sept. 30. He was born at Eliot, Maine, May 21, 1842, and was appointed Assistant Naval Constructor in 1875. He was promoted to the rank of Naval Constructor in 1888. He was Superintendent of Construction of the warships "Alabama" and "Maine," 1898-1903, and was senior member of the board on hull changes for ships building on the Atlantic coast. He was retired in 1904 with the rank of Rear-Admiral.

Engineering Societies

COMING MEETINGS

COOPERATIVE SAFETY CONGRESS.
Sept. 30-Oct. 5. Annual convention at Milwaukee, Wis. Chairman, L. R. Palmer, 5852 Douglas Ave., East Pittsburgh, Penn.

AMERICAN ASSOCIATION FOR HIGHWAY IMPROVEMENTS.
Sept. 30-Oct. 5. Annual convention at Atlantic City, N. J. Secy., G. E. Pennybacker, Jr., Colorado Bldg., Washington, D. C.

NATIONAL CONSERVATION CONGRESS.
Oct. 1-4. Annual meeting at Indianapolis, Ind. Secy., Thos. R. Ship, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 7-11. Annual convention at Chicago, Ill. Secy., H. C. Donecker, 29 W. 39th St., N. Y. City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 8-11. Annual Convention at Quebec, Canada. Secy., C. C. Rosenberg, Times Bldg., Bethlehem, Penn.

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION.
Oct. 15-17. Annual convention at Baltimore, Md. Secy., C. A. Lichty, 226 Jackson Blvd., Chicago, Ill.

AMERICAN GAS INSTITUTE.
Oct. 16-18. Annual meeting at Atlantic City, N. J. Secy., Geo. G. Ramsdell, 29 West 39th St., New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.
Oct. 21-25. Annual meeting at Chicago, Ill. Secy., T. A. Andreucetti, C. & N. W. Ry., Chicago, Ill.

AMERICAN ASSOCIATION FOR THE PREVENTION OF THE POLLUTION OF RIVERS AND WATERWAYS.
Oct. 23-24. Annual convention at Cleveland, Ohio. Secy., H. De B. Parsons, 22 William St., New York.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS
Nov. 12-15. Annual convention at Dallas, Texas. Secy., A. P. Folwell, 50 Union Square, New York.

RAILWAY DEVELOPMENT ASSOCIATION.
Nov. 17. Annual meeting at Cincinnati, Ohio. Secy., W. Nicholson, K. C. So. Ry., Kansas City, Mo.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 19. Annual convention at Washington, D. C. Secy., W. H. Connolly, Washington, D. C.

AMERICAN CIVIC ASSOCIATION.
Nov. 19-22. Annual convention at Baltimore, Md. Secy., Richard B. Watrous, Union Trust Bldg., Washington, D. C.

AMERICAN RAILWAY ASSOCIATION.
Nov. 20. Annual meeting at Chicago, Ill. Secy., W. F. Allen, 75 Church St., New York.

NATIONAL FOUNDERS ASSOCIATION.
Nov. 20-21. Annual convention at New York, N. Y. Secy., J. M. Taylor, 29 So. La Salle St., Chicago, Ill.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 21-22. Annual meeting at New York, N. Y. Secy., D. H. Cox, 29 W. 39th St., New York.

AMERICAN MINING CONGRESS.
Nov. 25-28. Annual convention at Spokane, Wash. Secy., J. F. Callbreath, Denver, Colo.

Detroit Engineering Society—At the regular meeting of the Society on Sept. 27, J. W. Parker spoke on the subject of "Power Plant Testing," touching particularly on operating economies.

Associated Engineering Societies of St. Louis—At a meeting, on Oct. 2, held under the auspices of the St. Louis Association, A. S. C. E., a paper was presented by Carl Gayler, on "The Reinforced Concrete Column."

American Society of Civil Engineers—The paper by H. G. Burrowes, entitled "The Sixth Avenue Subway of the Hudson and Manhattan Railroad," was discussed at the regular meeting of the Society on Oct. 2.

American Society of Mechanical Engineers—The subject of "Smoke Abatement" will be discussed at the meeting of the Society on Oct. 8, and discussion will be opened by G. H. Perkins, who represented the A. S. M. E. at the International Smoke Abatement Exhibition and Conference, held in London last March.

American Mining Congress—The 15th Annual Convention is to be held at Spokane, Wash., on Nov. 25-28. The following are among the important general questions upon which papers will be given: conservation, workmen's compensation, mine taxation, Federal control of mineral lands, water power, right of way over public domain, the use of electricity in mining operations, and Federal aid for mining schools.

American Foundrymen's Association—The following were among the papers given at the 17th Annual Convention of the Association, at Buffalo, N. Y., Sept. 24-26: "Mechanical Sand Tempering," by V. E. Minich; "Melting Scrap," by A. W. Moyer; "Electric Welding," by J. F. Lincoln; "The Bonus System as Applied to the Finishing Department of a Steel Foundry," by A. W. Gregg; and "Accident Prevention and Safety Devices for the Foundry," by W. H. Cameron.